United States
Department of
Agriculture

Forest
Service

Wild Horse Report

for the Ochoco Wild Horse Herd Management Plan Environmental Assessment

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Introduction

This wild horse report will focus on the effects to wild horses from the actions proposed in the Ochoco Wild Horse Herd Management Plan Environmental Analysis (EA). The intent of this specialist report is to; describe the existing conditions in the Big Summit Territory including the wild horse herd itself, share the data and science providing the basis for those condition determinations, and describe the effects of the actions proposed by alternatives on wild horses. This report also includes the Appropriate Management Level (AML) Analysis which was used to determine the proposed AML.

The Key Issue to be addressed in this report is the AML. The AML, or range of wild horse numbers to be managed within the Big Summit Territory, affects other natural resources like forage conditions, riparian vegetation, big game habitat and permitted livestock. The AML also affects the wild horse herd, their cover and space needs, genetics and social behaviors.

Regulatory Framework

The Wild Free-Roaming Horses and Burros Act of 1971 as amended (WFRHBA)

The Federal Land Policy and Management Act of 1976 (FLPMA)

The Public Rangelands Improvement Act of 1978 as amended (PRIA)

36 CFR 222 Subpart D, Management of Wild Free-Roaming Horses and Burros

Forest Service Manual 2260-Wild Free-Roaming Horses and Burros (FSM 2260)

Ochoco National Forest Land and Resource Management Plan (LRMP)

LRMP Direction:

Forage and Livestock Use (4-11)

Forage Utilization Standards and Guidelines (4-141)

Analysis Methods

The analysis method is based on the review of existing conditions in the Big Summit Territory, relevant scientific literature, Forest Service Manual direction and professional expertise.

The existing conditions for the land and the wild horse herd were determined based on various data sets collected inside the Big Summit Territory including: surveys, photo points, Geographical Information System (GIS) data and personal observations. This will be discussed in detail in the Affected Environment section.

The factors to be analyzed for wild horses are:

- Herd Size (AML)
- Genetic variability

- Forage availability
- Fertility control
- Social behavior
- Wild horse capture and/or removal
- Off-range management

Affected Environment

The Big Summit Territory is located approximately 30 miles east of Prineville on the Ochoco National Forest. The Territory includes approximately 25,434 acres of forested habitat including Round Mountain and Duncan Butte. The general description of the Territory is a mix of ponderosa pine, Douglas-fir and other conifer trees with a variety of shrubs and grasses, creeks and small mountain meadows.

The Big Summit Territory is located in portions of the same legal description described in the 1975 EA:

T. 13 S., R. 20 E., Sections 20, 21, 27, 28, 29, 30, 31, 32, 33, 34, and 35

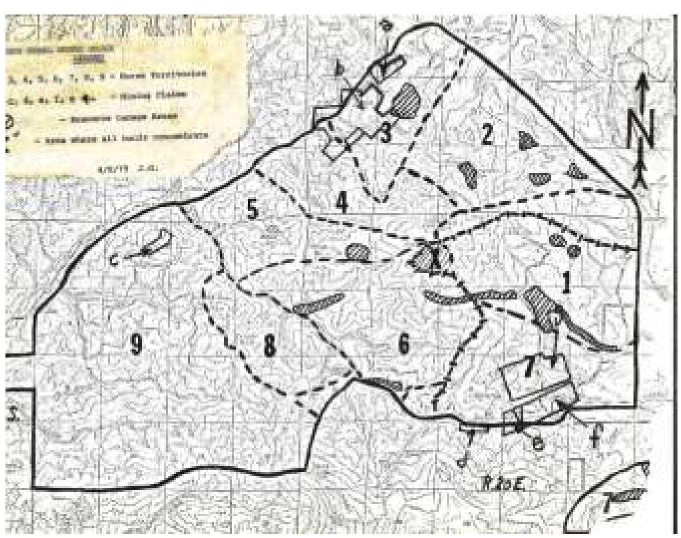
T. 13 S., R 19 E., Sections 34, 35 and 36

T. 14 S., R19 E., Sections 1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 16, 21, 22, 23, and 24

T. 14 S., R 20 E., Sections 2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 15, 16, 17, and 18

The legal description also estimated the acres at approximately 27,300 acres, of which, 27,060 acres Forest Service, 160 acres private and 80 acres Bureau of Land Management (BLM). There was also a reference to an attached map for the legal Territory boundary (see Photo 1). This map has been digitized with newer technology and was first digitized based on the legal description alone and with this project, re-digitized to the 1975 legal Territory map. This re-digitizing calculated the acres at 25,434, of which, 25,037 acres Forest Service, 319 acres private and 78 acres BLM. This re-digitizing and re-calculating is in alignment with the original Territory map as well as how the Territory has been actively managed on the ground because of fence lines.

Photo 1: Big Summit Territory Map (original/official)



There will be no effect associated with correcting this re-digitizing of the Territory on wild horses because the Forest has always attempted to keep the horses on the eastside of the western boundary. For example, in 2008 and 2009, the majority of the horses were located west of the western boundary in the Coyle Creek area. The fence had an opening that in 2008 was replaced with a metal gate and salt blocks were placed in the Territory and gates opened to lure horses back into the Territory. These salt blocks and gates were checked several times in 2008. Then on October 23, 2009, 24 horses were re-located inside the Territory from Coyle Creek by horseback.

Wild horses in the Big Summit Territory form several dynamic bands that range in size and kind; there are bachelor bands of between 3-5 horses and family bands anywhere from 3-20 plus horses depending on the time of year. Most horses tend toward dark bay and black coat colors unique facial or body markings. In the spring to summer, horses can be observed grazing in open meadows in great body condition while in the winter time, horses can be observed roaming for forage at the base of trees or on southern slopes were the snow is less of a barrier. During the winter horses tend to be poorer body condition, with general body condition declining as the harshness of the winter increases.

The existing Ochoco Wild and Free-Roaming Horse Management Plan (Plan) was approved in 1975 following the passage of the Wild Free-Roaming Horse and Burro Act of 1971. This Plan set an Appropriate Management Level (AML) of 55-65 horses. The Ochoco National Forest Land and Resource Management Plan (LRMP) was approved in 1989 and states that the Territory will be managed at a maximum of 60 horses. The latest estimate of the number of wild horses in and around the Big Summit Wild Horse Territory is 135 horses.

The resource elements selected to be focused on in this report are wild horses, upland forage, riparian forage and forage allocation. Because this is an EA to develop and updated Herd Management Plan (HMP) for the wild horses in the Big Summit Territory, wild horses are the main focus. This would include a description of the horses themselves, how they use the Territory, their social and genetic makeup and management actions. The other resource elements are focused on forage, a basic need for wild horses, but also the point of competition with other multiple uses managed for inside the Big Summit Territory and the driver for the AML.

Resource Element 1-Wild Horses

Background

Horses originated in the project area around the 1920s according to the existing Herd Management Plan (USDA Forest Service, 1975a). According to this source these horses escaped from or were set loose by different ranchers in the surrounding areas including Post, Mitchell and Prineville. Ultimately, these free-roaming horses established their territories around Round Mountain and their numbers were kept at around 60 horses by local “horse chasers,” natural deaths and predators (USDA Forest Service, 1975a).

The passage of the Wild Free-Roaming Horses and Burros Act (Act) of 1971 established a need to protect horses and burros from “continuing depredation by man” (US Congress, 1971). When the

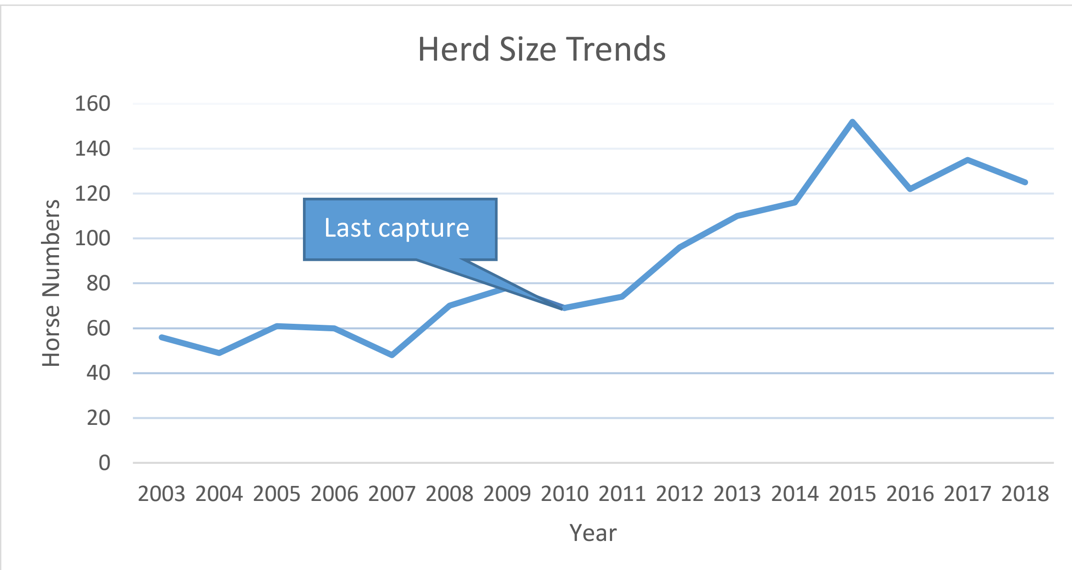
Act passed, it gave authority to the Secretaries of Interior and Agriculture to manage wild free-roaming horses and burros as an integral part of the natural system. The Act also directed the Secretaries to designate specific areas on public lands for protection and preservation of horses. Any horses that were unbranded and unclaimed on designated public lands at the passing of the Act, would be protected and managed.

Once the Act was passed, Ochoco National Forest staff began the process to determine how many unbranded and unclaimed horses were on the public lands and where to establish the territory boundary. During that process, several claims were made of horses on public lands owned by surrounding individuals, those horses were then considered not unclaimed and removed off public lands and reunited with their owners. Ochoco National Forest staff also determined how many unbranded and unclaimed horses were occupying public lands at that time. They identified ten bands of horses, approximately 60 horses total, on approximately 27,300 acres which was mapped and designated as the Big Summit Territory (USDA Forest Service, 1975b, Photo 2). They then completed an Environmental Analysis and established an AML of 55-65 horses.

Photo 2: Horse band from 1977

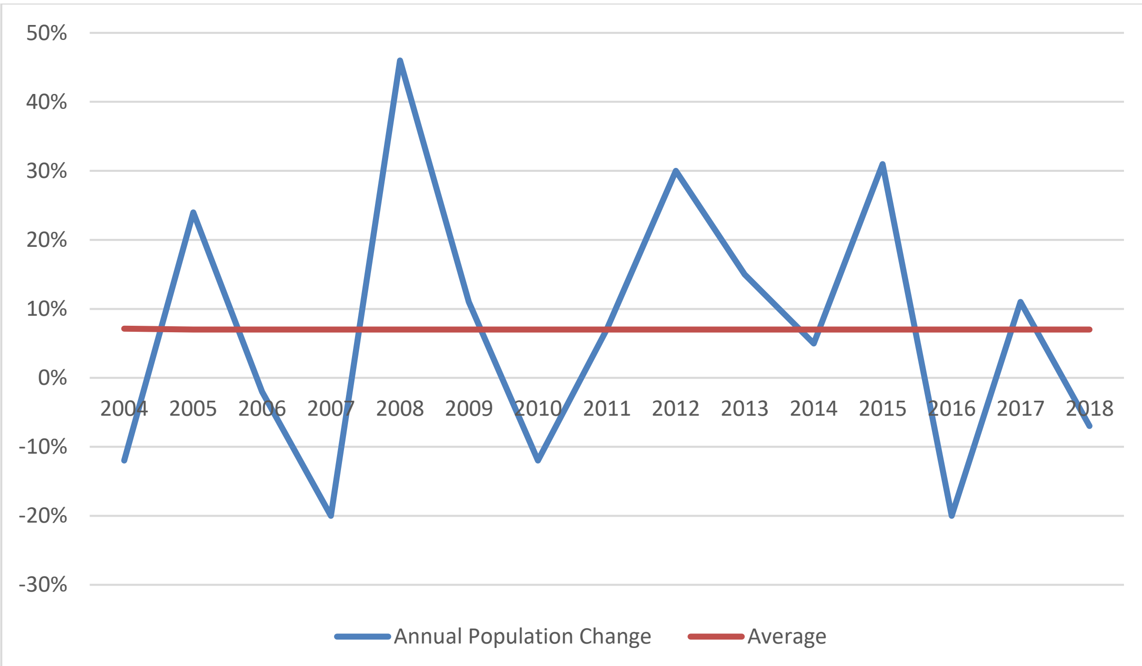
The Ochoco wild horses on Big Summit Territory are typically of bay to black coloring and short stature. Many of the horses have some sort of unique markings to help identify individuals, including blazes (white facial markings) or stockings (white coloring on legs). Every June since 2003, in partnership with the Central Oregon Wild Horse Coalition, Forest Service volunteers have gathered for a three-day ground based inventory. The results of that ground based count provide a minimum herd number annually and can be used to estimate a general trend over time (see Table 1). Starting in 2014, individual horses were identified with photos and individual information was cataloged. A total of 123 horses are currently cataloged by the staff at the Lookout Mountain Ranger District. There are 57 studs, 55 mares and 11 unknowns identified, a proportion of 46% studs, 45% mares and 9% unknown. In 2018, in addition to the June ground based inventory which counted a minimum of 125 horses, in September 2018, an infrared flight detected 119 horses (Owyhee Aerial Research Inc. 2018), and when combined with the 16 horses observed by Forest Service staff outside the survey area, the number of horses at that time was estimated at a minimum of 135, which is over 2 times the maximum level of 60 horses allowed in the LRMP. Since it is reasonable to assume the gender ratio of the uncatalogued animals is similar to the ratio of the horses that have been catalogued we project that at that time we had at least 62 studs and 61 mares with 12 horses of unknown gender.

Table 1: Herd size trends based on ground based inventory



The herd has been managed for the AML of 55-65 until the last capture of 2010, since then the herd has increased. The average population growth of this herd appears to be around 7-8% with high annual variation (see Table 2 for annual variation). The population changes are taken from the annual inventory which can have a high variability of detection, therefore the annual inventory represents a minimum number of horses on the territory. Horse detection varies based on number of volunteers present, area covered, horse location, horse behavior, weather variabilities and so forth. There is little evidence of predation on the herd as a factor in affecting population growth. While we know there are black bears and cougars present in the Territory, there are few personal observations of black bear or cougar kills on wild horses in the Territory.

Table 2: Annual population change of herd over time



When the 1975 Ochoco wild horse plan was finished, implementation of the plan began with the first capture of wild horses in 1977. Since then, continuous captures were used to maintain the AML of 55-65 horses until 2011 Table 3). In the 1970s through the early 2000s, excess horses were captured primarily using a combination of tranquilizer guns, wing traps and wranglers. Until 1981, excess wild horses were cared for and prepared for adoption through the corral located on the Ochoco National Forest near the old Big Summit Ranger Station. Beginning in 1981, excess wild horses were transported to the Burns wild horse facility in Hines, Oregon

under an Interagency Agreement where they were processed, cared for and adopted out. In the early 2000s the primary method for capture and removals of excess wild horses was bait trapping. Excess wild horses were captured to maintain AML until 2011.

Table 3: Capture and Removal Data for the Big Summit Territory

Date	Horses Gathered	Comments
1977	41	60% horses removed were studs, wing trap method, very little snow, all horses adopted within 2 months
1981-1982	27	About 50% horses removed were studs, all horses hauled to Burns BLM facility
8/3-8/25 1982	15	4 studs, 6 mares, 4 colts and 1 filly hauled to Burns BLM facility
1983	26	About 1/3 horses removed were studs, hauled to Burns BLM facility
1984	32	Just under 50% horses removed were studs, hauled to Burns BLM facility
1985	1	1 stud removed and hauled to BLM facility
1988	12	1/3 horses removed were studs, hauled to Burns BLM facility
1993	19	Severe winter in January required removal of horses staying on country road due to public safety concern, majority of horses in poor condition, hauled to the Burns BLM facility
1998	5	Hauled to the Burns BLM facility
1999	16	Hauled to the Burns BLM facility
2000	2	Hauled to the Burns BLM facility
2002	23	1/3 horses removed were studs, contract bait trap removal, hauled to the Burns BLM facility
2003	3	Bachelor band removed that was outside Territory, hauled to the Burns BLM facility
2004	2	Hauled to the Burns BLM facility
2005	1	Stud located on private land, hauled to the Burns BLM facility

Date	Horses Gathered	Comments
2006	12	Hauled to the Burns BLM facility
2007	4	Hauled to the Burns BLM facility
2009	4	BLM capture contract, wing trap and helicopter, hauled to the Burns BLM facility
2010	18	3 bands captured by bait trap, 8 horses returned including 2 horses from the South Steins HMA
2012	1	Hauled to the Burns BLM facility
2015	2	Injured foal captured and Colt captured and adopted locally
2016	1	Injured mare adopted locally
2017	1	Yearling stud captured and removed, heavy winter left stud in poor condition, adopted locally
2018	1	Stud captured and adopted locally

Forest Service operations changed in 2014. First, the National Agreement between the Forest Service and BLM was changed to authorize payment for holding by the BLM of only Forest Service wild horses that were currently in long-term or short-term care and adoption of Forest Service wild horses that were in BLM facilities prior to October 13, 2013. According to the existing National agreement in the future local Forest Service offices are required to enter into local agreements if they wish to use the BLM to meet additional needs for handling wild horses newly removed from the Territory. These changes affected the gather and removal process for Forest Service wild horse animals and their placement into BLM holding facilities. Second, the Ochoco National Forest was preparing to update the herd management plan, including reassessing the AML determination based on changed conditions in the Territory.

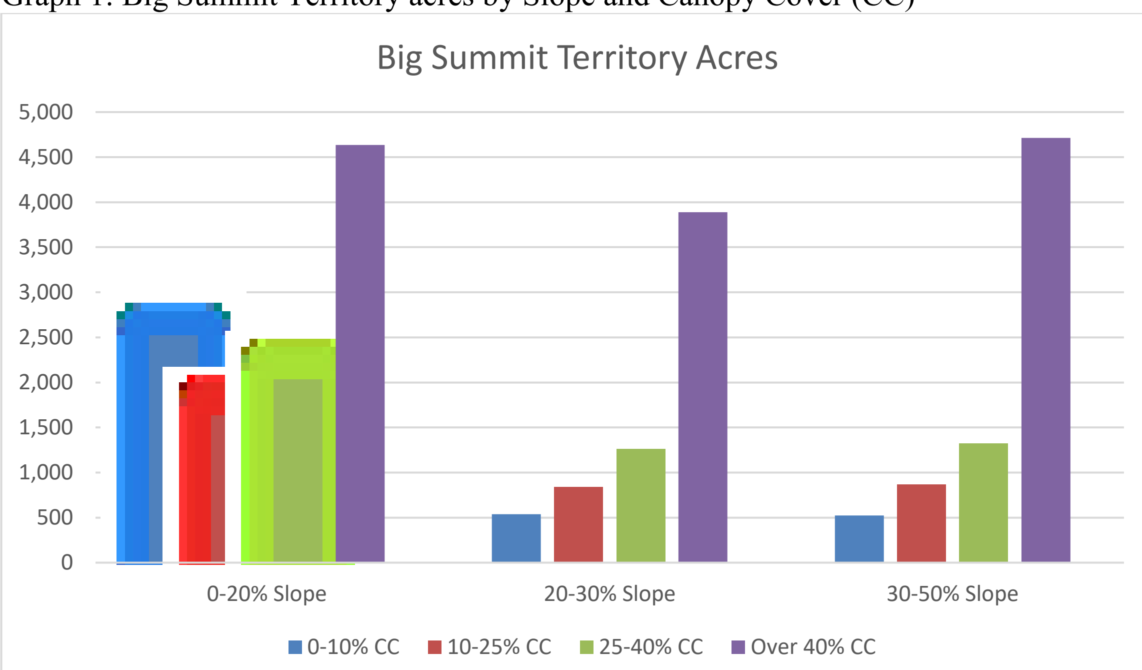
Habitat

Within the approximately 25,434 acre Big Summit Territory, there is a variety of plant communities, conditions, slopes and aspects that make some areas primary habitat for horses and other areas less suitable. Horse observations within the Big Summit Territory appear to be consistent with research that shows that wild horses prefer slopes ranging from 0-19% (Ganskopp & Vavra, 1987). Also, research shows that canopy cover has direct effects on understory plants, which provide forage for wild horses. Specifically, once overstory canopy cover is higher than 40%, the understory resources are very limited (Jameson, 1967 and McConnell & Smith, 1965). This is classified as transitory range, the primary make-up of the Big Summit Territory. There are many studies that look at habitat use by horses, but they are primarily in very different habitats than occur within the Big Summit Territory (Ganskopp & Vavra, 1986, Miller, 1983, Crane et al., 1997, Salter & Hudson, 1979). Three conclusions from these studies appear to be applicable to the Big Summit Territory:

- Riparian areas are preferred habitat (Crane et al., 1997)
- Horses spend most of their time feeding (Crane et al., 1997 and Salter & Hudson, 1979)
- The availability of preferred forage plants appeared to be the primary habitat use indicator during all seasons (Salter & Hudson, 1979).

The Big Summit Territory has a wide variety of habitat in the 25,343 acres; for example, there are approximately 421 acres of riparian areas in the Territory. There is also a variable range of acres in amount of slope and canopy cover throughout the Territory, all open to the use of wild horses. Graph 1 below shows the break out of acres in the Territory for up to 50% slope and various percent canopy cover. In all three slope classes, the largest number of acres is in the highest category of canopy cover, over 40%. These acres would be the least suitable for wild horse habitat, however they would still be expected to occasionally travel through these areas.

Graph 1: Big Summit Territory acres by Slope and Canopy Cover (CC)



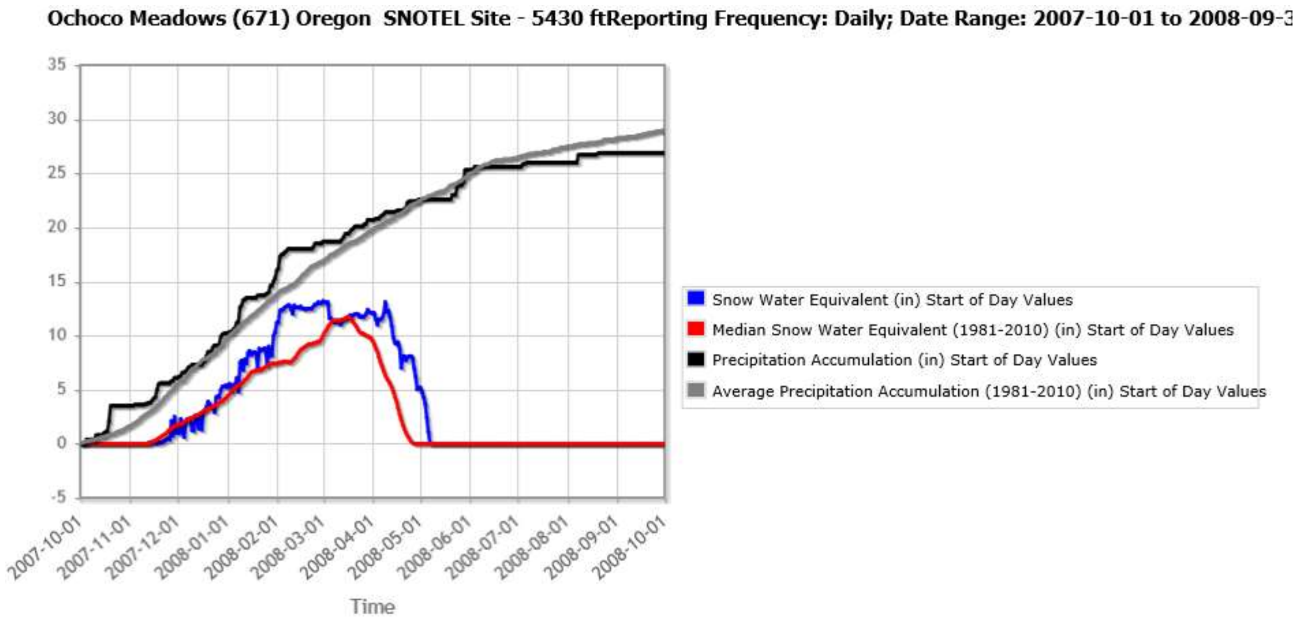
Based on the apparent preferences listed above, not all areas are well suited to provide for the needs of wild horses nor are all areas utilized equally. The best suitability would be represented by the forage abundance and gentle slopes; therefore, horses would be expected to primarily utilize the areas with 0-20% slope and less than 40% canopy cover (highlighted in Graph X), which occurs on approximately 6,191 acres, or 24%, of the 25,434 acre Territory.

Since 2003, a ground based inventory has been conducted annually including an attempted count of horses that are outside of the Big Summit Territory. Although there is no discernable relation between total herd size and the number of horses outside the Territory, personal observations seem to indicate increased pressure from horses attempting to move further outside of the Territory when the numbers increased. Horses have been counted outside of the Territory every year although there is no way to determine how many horses are missed either inside or outside the Territory each year. While the Territory itself is free of any fences, there are fence lines that border the west side and eastside of the Territory and the south side is a mix of natural barriers and fences. The north side of the Territory is not bounded by a fence but a let-down fence occurs 1-2 miles outside of the Territory boundary.

Wild Horse Winter Range

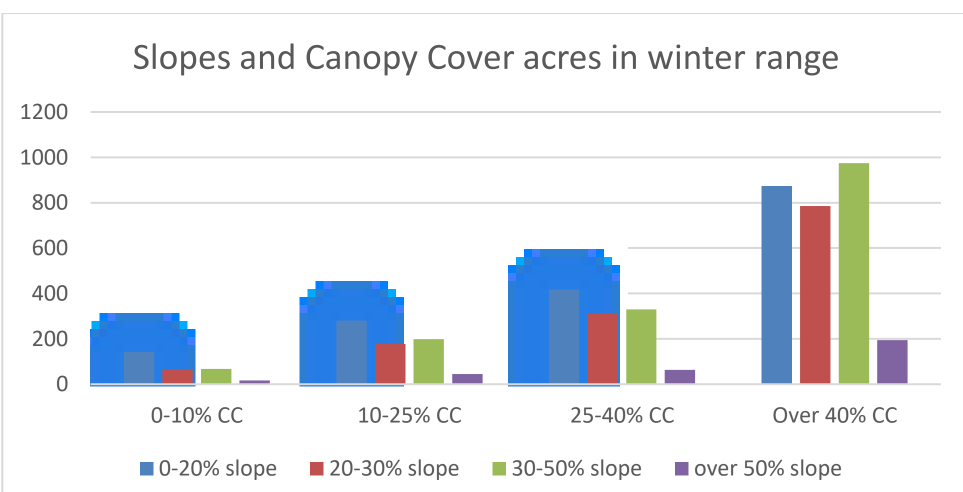
The determination of wild horse winter range (the area wild horses primarily use during winters with above average snowfall) is a key component of the AML Analysis (Appendix 5). Through that process, we identified a winter range inside the Big Summit Territory of 4,942 acres. This winter range was based on two winters with above average snowfall (2008 & 2016, see Photo 3) and the observed presence of horses during those winters. This wild horse winter range also partially overlaps with the General Forest Winter Range management area of the Ochoco LRMP, with a diverse mix of plant communities ranging from meadows to forested communities. There is also a high variety of slopes and canopy covers within this area. The wild horse's pattern of habitat use during the winter varies depending upon the severity of the winter and the production of the prior growing season however wild horses are consistently present in the area determined to be wild horse winter range during winter time.

Photo 3: 2008 Snow depth peak percentage



While there is not a clear pattern of habitat use, Salter & Hudson found the horses in their 1979 study in the foothills of the Alberta Rockies that the availability of preferred forage plants appeared to be the primary habitat use indicator during all seasons (Salter & Hudson, 1979). Salter and Hudson observed horses foraging in snow up to 60 cm (approximately 2 feet) in depth (the deepest snow during the study) and found that horses would paw in deep snow and horses could feed in shallow snow without pawing using their muzzle to push the snow away. Horses also took advantage of reduced snow-depths at tree bases and on south-facing slopes where reduced snow depth throughout the winter may be found (Salter & Hudson, 1979). Preferred forage plants are located on flatter slopes with canopy cover less than 40%, this makes up 839 acres, or 17%, of the 4,942 acre winter range (highlighted in Table 4). Slopes in the winter range vary from less than 5% to over 50%. Slopes and canopy cover classes are displayed by acres in the following tables:

Table 4: Slope and canopy cover class by acres in the wild horse winter range



Genetic Health

In the 2013 National Research Council's synthesis chapter for, Genetic Diversity in Free-Ranging Horse and Burro Populations, they indicate that, "Isolation and small population size in combination with the effects of genetic drift, may reduce genetic diversity to the point where herds suffer from the reduced fitness often associated with inbreeding. … The maintenance of genetic diversity in a population is a function of the genetic effective population size. … It was originally thought that an effective population size of at least 50 was necessary to avoid short-term inbreeding depression, but empirical work suggest that if maintenance of fitness is important, effective population sizes much larger than 50 are necessary. Theoretical studies suggest that the figure could be closer to 5000 for several reasons. … so no single HMA or complex could be considered to have a [minimum viable population] size for the long term …" (National Research Council 2013). Since it can easily be argued that maintenance of genetic health of a wild horse herd is required in order to meet the "thriving natural ecological balance" standard of the Act a description of the current genetic condition of the herd and how subsequent management actions associated with the alternatives will both monitor and manage the genetic condition of the herd are advisable.

Two genetic studies have been conducted on the Big Summit wild horses; both studies indicate low genetic variability. The first study, led by Dr. Mills from Florida International University, began in 2006 with the purpose of identifying a non-invasive sampling method for genetic testing and counting of the horses in the Big Summit Territory. The study unsuccessfully attempted to use fecal samples to identify individual horses. This method of sampling was not successful because the technology used could not distinguish between plant and animal DNA. As an alternative horse hair samples were collected from captured and adopted horses or from "noon trees" within the Big Summit Territory. Horse DNA was successfully extracted from hair samples and amplified. This study also showed many of the captured horses were closely related which could be indicative of a small herd that is inbred; alternatively, the hair samples may have come from whole family units captured before the offspring and siblings could naturally disperse to other areas (Mills, 2010). An article published from the study (Deshpande et al., 2019) further discusses the deficiency of heterozygosity and a positive inbreeding coefficient from 33 samples of the Big Summit wild horses.

The second study was of genetics analysis of the Big Summit Territory horses which was completed in 2011 by E. Gus Cothran from Texas A&M University utilizing 12 samples which came from two different captured bands of six. DNA was extracted from the samples and tested for variation at 12 microsatellite (mSat) systems. As described in BLM Manual H-4700-1 Wild Horse and Burros Management Handbook, Section 4.4.6.2 Interpreting Genetics Data, the observed heterozygosity (*Ho*) is a measure of how much diversity is found, on average, within individual animals in a wild horse herd. *Ho* is insensitive to sample size, although the larger the sample, the more robust the estimate. The 2011 report indicated that the values related to allelic diversity are not reliable due to the smaller sample size but *Ho* is below the critical level and this measurement is not influenced by sample size. The mean *Ho* values for each band was 0.653 and 0.583, BLM identifies anything below 0.66 as at critical risk.

The genetic report concluded that, "[o]verall similarity of the Big Summit [Territory] herd to domestic breeds was low for a feral herd which is expected with a small sample size. Highest mean genetic similarity of the Big Summit [Territory] herd for both samplings was with the Old World Iberian breeds, and the herd clustered with the Andalusian consistently. … Although it is difficult to have much confidence in this result, the consistent evidence for Spanish relationship should be examined with a larger sample if possible (Cothran 2011). Cothran summarized that current variability levels for the Big Summit herd are below the critical level. Cothran explained that the *Ho* values suggest that the herd has serious variability reduction and that more information is needed before specific management actions can be recommended.

Resource Element 2-Upland Vegetation

Of the approximately 25,434 acres inside the Big Summit Territory, approximately 24,508 acres or approximately 96% is composed of upland plant associations that provide some forage. These plant associations are categorized as transitory range. Transitory range is defined as forested lands that are suitable for grazing for a limited time following a complete or partial forest removal (Holechek et al., 2000). These transitory range uplands primarily consist of an overstory tree canopy, typically ponderosa pine or Douglas-fir, with an understory of mixed grasses and forbs. These areas have been mapped -plant association groups (PAG) in Geographical Information Systems (GIS). Seventy-five percent of the upland forage acreage in the Big Summit Territory falls into 5 plant association groups, these are listed in Table 5. The remaining twenty-five percent of forage acreage is a mix of non-forested plant association groups including those characterized by shrubs and juniper.

Table 5: Five major plant association groups (PAG) comprising 75% of upland forage acreage in the Big Summit Territory

PAG Code	Plant Association Group	Acres	Percent of Uplands
CWG113	Grand fir/pinegrass	7,576	31%
CDG112	Douglas-fir/pinegrass	5,202	21%
CWG211	Grand fir/brome	2,583	11%
CPG222	Ponderosa pine/bitterbrush/elk sedge	1,517	6%
CDSD	Douglas-fir/mountain mahogany	1,386	6%

Upland vegetation ratings were assessed using existing Parker 3-Step Condition and Trend (C&T) transects (Parker, 1951) in or adjacent to the Territory. The adjacent clusters (Reservoir 1 & 2) where used to represent conditions of the Territory because there is no barriers between the Territory and the clusters so horses can and there is evidence of them being present in the areas. C & T clusters consider frequency of upland species along a 100 foot transect(s) including identifying species presence. When this protocol is repeated over time, changes can be detected and apparent trends of vegetation changes can be determined. There are two C & T clusters that were utilized for determining upland vegetation ratings in the Big Summit Territory (Photo 4). At the monitoring sites, the vegetation ratings were fair to poor, with the latest reading on the clusters in 2015. The data from these vegetative ratings displays a downward trend (see Table 6) from 2004 to 2015.

Table 6: C & T Upland Vegetation Ratings within the Big Summit Territory

CONDITIONS ANDS TREND (PARKER 3-STEP)					
	Plant Association Group	**Vegetation Rating**			
		Reading 1 (1964)	**Reading 2 (2004)**	**Reading 3 (2015)**	**Overall Trend**
Canyon Creek C&T2a	Ponderosa pine/elk sedge	FAIR	GOOD	FAIR	
Reservoir C&T 2*	Ponderosa pine/elk sedge	GOOD	GOOD	FAIR	

*Adjacent to the Territory

Photo 4: Canyon Creek C & T 2a, Transect 3 (example)

1964 | 2004 | 2015

Nested Frequency transects in and adjacent to the Territory were also established in 2015 and read at existing C&T monitoring sites. Nested Frequency is another way to collect upland vegetation frequency data and detect changes over time which represent apparent trends (Photo 5). The nested approach has the advantage of more sensitivity in capturing the frequency of each lifeform and is less sensitive to the effect of year-to-year climatic fluctuations and the subsequent variation in plant canopy coverage that occurs (USDA Forest Service, 2007). Because only one reading has occurred, no trend information is available from the data. These measures and rating results are represented in the Table 7 that follows.

Table 7: Nested Frequency Data results in the Big Summit Territory

NESTED FREQUENCY			
	Plant Association Group	**Successional Stage**	**Dominant Cover Type**
Canyon Creek NF 1	Dry Meadow	Mid-seral	Litter (45%)
Canyon Creek NF 2	Dry Meadow	Mid-seral	Litter (61%)

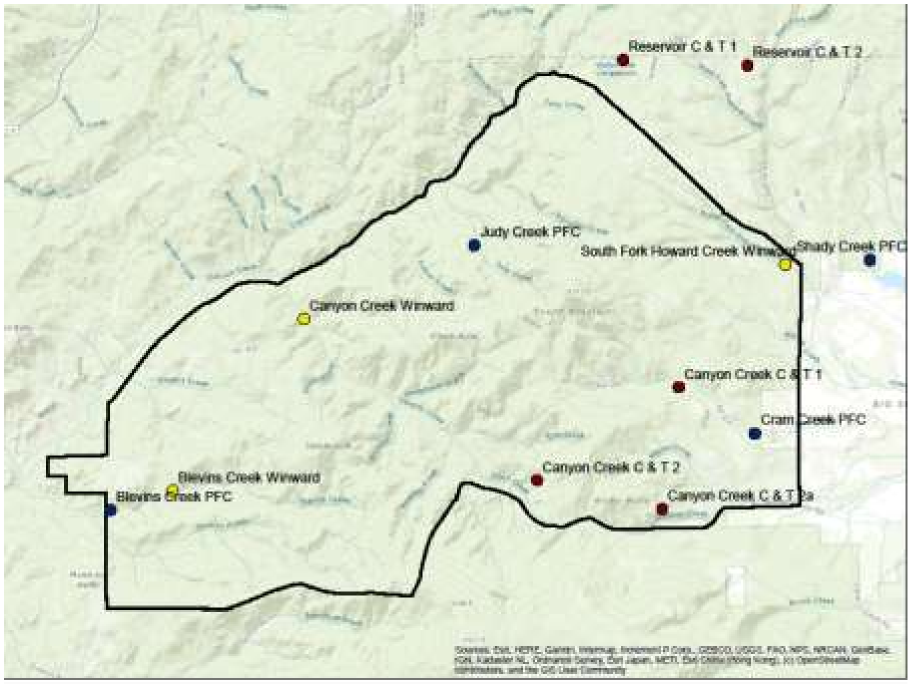
Canyon Creek NF 2a	Ponderosa pine/elk sedge community	Mid-seral	Litter (74%)
Reservoir NF 1	Dry Meadow	Early to Mid-seral	Litter (52%)
Reservoir NF 2	Ponderosa pine/elk sedge community	Mid-seral	Litter (78%)

Photo 5: Canyon Creek Nested Frequency 2a, Belt 1 (example)

The Ochoco National Forest LRMP sets forage objectives and Desired Future Condition (DFC) (USDA Forest Service, 1989). Specifically, the forage objectives and DFCs are to have range conditions in good or excellent. Based on the C & T data at the two ponderosa pine/elk sedge upland communities, which represents upland forage condition, neither of these sites have met the forage objective of good condition, they are currently in fair condition with an apparent downward trend. Furthermore, the LRMP provides forage upland utilization standards and guidelines to be applied based on a site's current conditions (satisfactory or unsatisfactory). Satisfactory condition is defined in the LRMP as forage condition is at least fair, with stable trend while unsatisfactory condition simply does not meet the criteria for satisfactory condition. Therefore, currently our uplands inside the Big Summit Territory are in unsatisfactory forage condition and do not meet the forage objectives or DFCs of the LRMP.

There are many factors that have led to the current forage condition of the uplands. These include historic grazing practices and increased forest canopy cover because of limited vegetation management activities, specifically logging activities and fire management. As stated previously, the majority of upland vegetation is transitory range whose production declines as forest canopies fill in and close, usually requiring a disturbance that opens the forest canopy in order to increase forage production. In other words, understory production is inversely related to overstory cover, "cutting and burning of the forest may promote development of understory vegetation" (Holechek, et al., 2000).

Map 1: Data points spread throughout and adjacent to the Territory



Resource Element 3-Riparian Vegetation

There are approximately 926 acres of riparian areas producing forage inside the Big Summit Territory. Plant Association Groups (PAG) are mapped for these areas in the Potential Natural Vegetation (PNV) layer of our Geographical Information Systems (GIS). There are six Plant Association Groups (PAGs) that comprise the riparian areas inside the Big Summit Territory, these are listed in Table 8.

Table 8: PNV groups of riparian forage in the Big Summit Territory

PNV Code	Plant Association Group	Acres	Percent of Riparian Areas
FW50	Wetlands	336	36%
SW20	Alder wetlands	254	27%
MD	Dry Meadow	152	16%
MW	Wet Meadow	133	14%
HQ	Quaking Aspen	40	4%
HC	Poplar Bottomlands	11	1%

Riparian vegetation was assessed using the C & T surveys for the Dry Meadows, Winward Riparian Studies and Proper Functioning Condition (PFC) assessments. The C & T data summaries can be found below in Table 9. For the three C & T clusters in Dry Meadows, one cluster was in fair vegetative rating and two were in poor vegetative rating. Data from clusters Canyon Creek 2 displays poor vegetative condition and is in an apparent static trend from 2004 and 2015, data from Canyon Creek 1 displays a fair forage condition with a downward trend from 1964 to 2015 and data from Reservoir 1 (Photo 6) displays a poor forage condition in a downward trend from 2004 to 2015.

Table 9: C & T Data Summaries for Riparian Areas

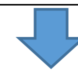
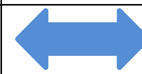
CONDITIONS ANDS TREND (PARKER 3-STEP)					
	Community Type	**Vegetation Rating**			
		Reading 1 (1964)	**Reading 2 (2004)**	**Reading 3 (2015)**	**Overall Trend**
Canyon Creek C&T 1	Dry Meadow	GOOD	Not located	FAIR	
Canyon Creek C&T 2	Dry Meadow	POOR	POOR	POOR	
Reservoir C&T 1	Dry Meadow	POOR	POOR	POOR	

Photo 6: Reservoir C & T 1, Transect 2 (example)

		
1964	2004	2015

Winward Riparian Studies consider three indicators of riparian conditions: greenline composition, vegetation cross section composition and woody species regeneration (USDA Forest Service, 2007 and Winward, 2000). Greenline composition indicates the relative cover of a plant species or community type in relation to other species or types along the water's edge. Vegetation cross section composition identifies the percentage of each vegetation community type in the riparian complex. Woody species regeneration captures the presences and condition of woody species on the greenline. Successional status can be derived from the greenline composition and vegetation cross section data collected. This in turn provides a general representation of riparian vegetation. In addition, woody species conditions and apparent trends can be determined. There were three Winward Riparian Studies read in the Big Summit Territory in 2015. Each of the three sites display variable conditions, the only consistency across the Territory is that all three sites display early to mid-seral successional status meaning the existing vegetation is indicative of the composition expected relatively recently following a disturbance. See Table 10 for information on the data collected at the studies.

Table 1: Winward Riparian Study data results for riparian vegetation in the Big Summit Territory

Drainage	Year	Cross-section Status	Greenline Status	Greenline Stability
Canyon Creek	2005	Early-seral	Mid-seral	Good
	2015	Early-seral	Mid-seral	Moderate
	TREND	↑	↑	↓
Blevins Creek	2005	Early-seral	Mid-seral	Good
	2015	Early-seral	Mid-seral	Moderate
	TREND	↓	↓	↓
SF Howard Creek	2005	Early-seral	Early-seral	Moderate
	2015	Early-seral	Mid-seral	Moderate
	TREND	↓	↑	↔

Ratings from Winward data are categorized as successional status, the higher percentage of undisturbed community types (late seral), the later the successional status.   A determination of whether a forage range condition is satisfactory or unsatisfactory can be derived by considering the successional status. Fair to good range conditions usually are associated with mid and high (equivalent to late) seral stages (equivalent to successional status) or potential natural vegetation (E.L. Smith, et al., 1995) and very early and early (equivalent to low) seral stages are considered roughly equivalent to poor range condition. The vegetation cross-section composition data may be considered the most informative regarding site response to grazing disturbance because it generally includes the range of vegetation communities within the riparian complex, including those that may be preferred by livestock and those that are most sensitive to grazing related disturbance. The data displays that all three sites in the Territory are dominated by early-seral species in the cross section ranging from 74-79% early seral species. Two of them are in an apparent downward trend from 2005-2015 (Photo 6) and one in an apparent upward trend from 2005-2015. Because all three sites are dominated by early-seral species, this could be considered roughly equivalent to a poor range condition, confirming that these riparian areas are in unsatisfactory condition.

Photo 6: Winward Blevins Creek-Cross-Section 3 (example)

Three Proper Functioning Condition (PFC) assessments were conducted inside the Big Summit Territory and one, Shady Creek, is adjacent to the Territory where horses have been seen and have no barriers for moving in and out of the area. The User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas (USDI BLM, 1998) states that, "Proper functioning condition (PFC) is a qualitative method for assessing the condition of riparian-wetland areas." Under the PFC protocol, creeks are broken into reaches and each reach is walked by an inter-disciplinary team and rated considering hydrologic, vegetative and erosional/depositional attributes and processes. Functional ratings and trends are qualitative, providing an initial assessment of condition. See Table 11 for PFC ratings conducted within the Big Summit Territory.

Table 11: PFC results for the Big Summit Territory

PROPER FUNCTIONING CONDITIONS			
DRAINAGE	**REACH**	**DISTANCE**	**FUNCTIONAL RATING/TREND**
Blevins Creek	1	0.75 miles	Functioning at Risk with No Apparent Trend
	2	0.25 miles	Functioning at Risk with No Apparent Trend
	3	0.25 miles	Functioning at Risk with No Apparent Trend
	4	0.75 miles	Functioning at Risk with No Apparent Trend
Cram Creek	1	0.75 miles	Functioning at Risk with a Downward Trend
	2	0.75 miles	Functioning at Risk with No Apparent Trend
	3	0.5 miles	Functioning at Risk with No Apparent Trend
	4	0.75 miles	Functioning at Risk with No Apparent Trend

	5	0.5 miles	Functioning at Risk with a Downward Trend
	6	0.5 miles	Functioning at Risk with No Apparent Trend
Judy Creek	3	0.75 miles	Functioning at Risk with a Downward Trend
	4	0.5 miles	Nonfunctional
	5	0.75 miles	Proper Functioning Condition
Shady Creek	1	0.5 miles	Functioning at Risk with an Upward Trend
	2	0.25 miles	Functioning at Risk with a Downward Trend

Additional information on riparian areas, such as stream survey data, can be found in the Aquatics Report; this additional data is consistent with a general unsatisfactory rating for the majority of the riparian areas in the Big Summit Territory.

The Ochoco National Forest LRMP sets objectives and describes desired future conditions for range condition (USDA Forest Service, 1989). Specifically, the LRMP sets an objective and expresses a desire that forest management will result in most riparian areas being in excellent condition by 2040. Based on the data collected from the C & T clusters at the three dry meadow communities, the three Winward riparian studies and the four PFC assessments, none of the riparian areas assessed within the Big Summit Territory are in good or excellent condition. Utilization rate standards and guidelines are set forth in the LRMP and are determined for each site depending upon, community type, current condition and "range resource management level" (management intensity). Satisfactory condition is defined in the LRMP as forage condition is at least fair, with stable trend, while unsatisfactory condition simply does not meet the criteria for satisfactory condition. Currently the riparian areas inside the Big Summit Territory are in unsatisfactory condition and do not meet the forage goal of the LRMP (Photo 7). Therefore utilization rate standards and guidelines that should be applied for riparian areas within the Big Summit Territory are those that apply to riparian areas in unsatisfactory condition.

Photo 7: Example of ripairan use from wild horses on Douthit Creek

There are many factors that have led to the existing conditions for the riparian areas in the Big Summit Territory. These are similar to the factors for upland range conditions which include historic grazing practices and vegetation management practices like logging and fire management. While upland forage production has an inverse relationship with overstory canopy cover, riparian forage production is inversely related to depth of water tables. Many stream channels within the project area have down cut at some point in the past, resulting in a lowering of the water table and a loss of riparian forage. Riparian forage is often utilized by many species and occurs in areas of gentle slopes that most foraging species prefer. At current wild horses numbers riparian areas within the wild horse winter range (and elsewhere) are showing consistent exceedance of the LRMP utilization rate standards and guidelines.

In the 1975 Environmental Analysis for the original herd management plan, 14 springs were identified in the Territory with five showing heavy use, seven medium use and one light use. In addition, 18 creeks in the Territory were referred to in that analysis with 12 showing heavy use, five medium use and one light use. Although monitoring efforts in recent years did not mimic all of the data collection that occurred for the 1975 analysis, there are still springs and creeks in the Territory that range from heavy through light use, for example, both Douthit spring (Photo 7) and Cram creek (Photo 8) currently display heavy use .

Photo 8: Example of hardwood utilization on Cram Creek inside the Territory

Competition for riparian forage between livestock, horses, and wildlife is limiting the regeneration and growth of hardwoods within the project area. While Winward Riparian data (Table 12) shows that there are an increase in the percent of young and saplings over time and there are more young then decadent or dead hardwoods present, livestock, horses and wildlife are limiting their growth by browsing. In this photo example above (**Error! Reference source not found.**), the hardwood would be considered a young or mature tree based on the number of stems and should be between 4.5 to 6 feet tall (Burton, et al., 2007), instead the hardwood is less than 12 inches tall due to the heavy browsing. Horses have been documented frequently in riparian areas and some studies have shown that horses consume or otherwise impact riparian shrubs decreasing the shrubs' height or impacting shrub presence (Davies & Boyd, 2019) (Beever & Brussard, 2000). In addition, both Nordquist, et.al. (2012) and Bork, et.al. (2012) found that horse use of browse increased in the winter. This is evident in the growth form and heavy browse use of hardwoods found throughout the wild horse winter range (**Error! Reference source not found.**).

Table 12: Winward Riparian Study data results for hardwoods in the Big Summit Territory

Drainage	Year	Hardwoods				
		% Seedling/ Sprout	% Young/ Sapling	% Mature	% Deca-dent	% Dead
Canyon Creek	2005	5%	10%	81%	0%	5%
	2015	7%	22%	63%	8%	0%
Blevins Creek	2005	4%	29%	66%	0%	0%
	2015	0%	68%	25%	0%	0%
SF Howard Creek	2005	5%	15%	77%	1%	2%
	2015	40%	23%	12%	10%	15%

Photo 9: Hardwood growth form in wild horse winter range

Resource Element 4-Forage Allocation

The designation of a Territory in accordance with the Wild and Free Roaming Horses and Burros Act (as amended) authorizes the additional multiple use of wild horses on those public lands, not the exclusive use. As stated in the Senate Report that accompanies the Act, "the principal goal of the Act was to provide for protection of horses from man and not…the single use management of areas for the benefit of wild free-roaming horses and burros. It is the intent of the committee that the wild free-roaming horses and burros be specifically incorporated as a component of the multiple-use management plans governing the use of the public lands" (US Congress, 1971).

The LRMP provides guidelines for allowable use of forage for the multiple resources managed by the Ochoco National Forest. The standard and guideline allows for different allowable use levels depending upon: community type (riparian communities or primary range communities) Range Resource Management Level (B-D based on management intensity), and the forage condition of the communities (satisfactory or unsatisfactory). These tables prescribe the cumulative annual use by big game and livestock which includes wild horses in the Big Summit Territory. See Tables 13 & 14 for specific allowable use levels.

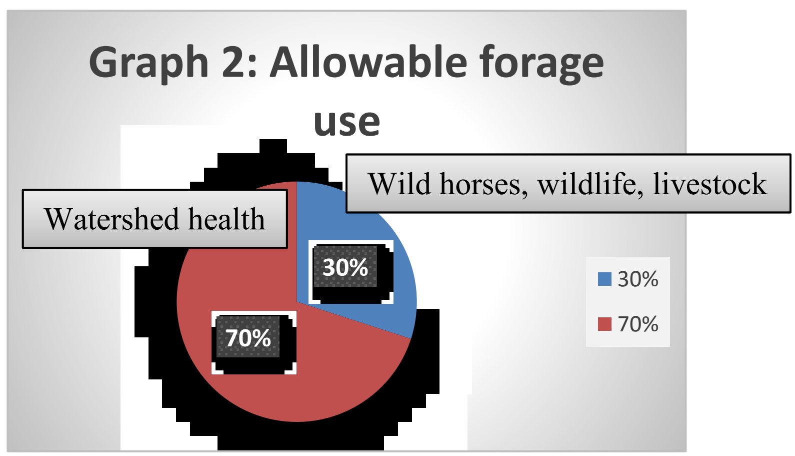
Table 13: Forest Plan Riparian Communities Forage Utilization

Range Resource Management Level	Grassland Communities		Shrubland Communities	
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
B-Livestock use managed within current grazing capacity by riding, herding, salting, and cost-effective improvements used only to maintain stewardship of the range.	40%	0-30%	30%	0-25%
C-Livestock management to achieve full utilization of allocated forage. Management systems designated to obtain distribution and maintain plant vigor include fencing and water developments.	45%	0-35%	40%	0-30%
D-Livestock managed to optimize forage production and utilization. Cost-effective cultural practices improving forage supply, forage use and livestock distribution may be combined with fencing and water development to implement complex grazing systems.	50%	0-40%	50%	0-35%

Table 14: Forest Plan Primary Range Communities (except Riparian) Forage Utilization

Range Resource Management Level	Forested Communities		Grassland Communities		Shrubland Communities	
	Sat.*	Unsat.*	Sat.*	Unsat.*	Sat.*	Unsat.*
B-Livestock use managed within current grazing capacity by riding, herding, salting, and cost-effective improvements used only to maintain stewardship of the range.	40%	0-30%	40%	0-30%	30%	0-25%
C-Livestock management to achieve full utilization of allocated forage. Management systems designated to obtain distribution and maintain plant vigor include fencing and water developments.	45%	0-35%	45%	0-35%	40%	0-30%
D-Livestock managed to optimize forage production and utilization. Cost-effective cultural practices improving forage supply, forage use and livestock distribution may be combined with fencing and water development to implement complex grazing systems.	50%	0-40%	50%	0-40%	50%	0-35%

Since the Wild Free-Roaming Horse and Burro Act of 1971 (WFRHBA) requires the Secretary to manage wild horses at a "minimal feasible level" range resource management level B is the level that corresponds to this management intensity. Because actual utilization levels within the Big Summit Territory and many research studies indicate that wild horses prefer riparian areas with flat slopes (Ganskopp & Vavra, 1987), the riparian communities allowable use rates are expected to be reached first. Lastly, as previously discussed riparian community conditions inside the wild horse winter range are in unsatisfactory condition.



The allowable use standard and guideline (for use by big game, livestock and wild horses) for Grassland Riparian Communities in unsatisfactory condition, managed under the Range Resource Management Level B is 0-30% (see Graph 2 on Allowable forage use). The remaining 70% of the forage production in the Territory is reserved to meet the objectives of "improving ecological condition and plant community stability" (LRMP 4-11).

When considering the AML for the Big Summit Territory, other multiple-uses in the area must be considered and the allowable use standard and guideline from the LRMP must be followed. Forage available under the cumulative allowable use rate of 0-30% (see Appendix 5: AML Analysis) must be divided amongst wild horses, wildlife and permitted livestock. On October 26, 2017, three riparian area sites in the winter range were measured for utilization and ranged from 71-80% riparian forage utilization. On September 27, 2018, these same three riparian areas were measured for utilization and ranged from 58-77% riparian forage utilization with permitted livestock rested this year. While permitted livestock numbers have stayed the same since the 1975 plan was written, both wildlife and wild horse numbers have increased causing a current shortfall of available forage based on resource conditions and periodic exceedance of allowable use rates as shown in the winter range utilization monitoring.

Summary of Affected Environment

Summary of the monitoring information indicates that overall resource conditions have declined since the 1975 Herd Management plan was implemented. There are several factors that have contributed to this resource decline. The biggest factor that appears to have affected upland forage condition is the increased conifer canopy cover. However, there appear to be several factors that have affected riparian condition, including conifer encroachment and loss of water table as well as a shortfall of available forage resulting in periodic exceedance of the allowable use standard and guideline. The current number of wild horses are contributing to the declined riparian conditions, as riparian areas have been repeatedly over-utilization by horses. Allowable use level is based on current resource conditions and must be partitioned among all of the multiple species competing for forage, in the Big Summit Territory this includes permitted livestock, wildlife species and wild horses. While permitted livestock numbers have remained the same since 1975, wildlife and wild horse numbers have increased resulting in an available forage shortfall.

Environmental Consequences

All three Alternatives include actions that will have varying effects on wild horses and forage. The affected environment discussion above categorized the four resource elements considered in this section: wild horses, upland vegetation, riparian vegetation and allowable use of forage. All three Alternatives will look at the same plan components and how those effect the same attributes differently, these components are outlined in Table 15 below.

Table 15: Environmental Consequence outline

Plan Component	Attribute	Measured by
AML	Wild Horses Riparian vegetation Upland vegetation	Herd size Horse body condition Forage utilization
	Allowable Use of Forage	Forage utilization
	Wild Horses	Observed heterozygosity
Managing for Genetic Diversity	Wild Horses	Observed heterozygosity
Population Growth Control	Wild Horses	Annual reproductive rates
Off-Range Plan	Wild Horses	Horse stress and injury

Effects from Gather of Excess Wild Horses (Bait Trapping)-All Alternatives

Gathering wild horses identified in excess of AML on the Big Summit Territory is a management tool used to reduce populations size and minimize negative impacts by wild horses on range and forest resources. Other management activities such as fertility control treatments, can be employed once horses have been gathered. The primary method of gathering excess wild horses on the Big Summit Territory or ones that have strayed off the Territory onto adjacent public or private lands is bait trapping. Bait trapping can be conducted year-round but is often more effective during certain seasons.

Bait trapping requires erecting temporary corrals constructed of metal panels and associated latching mechanisms (traps). As animals are drawn to the bait (feed, water, minerals, and another horse) they concentrate within each trap or holding facility. The mechanical disturbance associated with their hoof movement results in mortality and elimination of all vegetation, bait and manure is often spread across the entire trap and the soil surface is totally disturbed. Six bait trap sites have been identified on sites such as dispersed campsites that are already disturbed and that are large enough to erect a temporary trap, temporary holding facility and truck and trailer maneuverability. Other bait trap sites can be identified on a case by case basis following IDT review and recommendation, and approval by the authorized Forest officer.

Bait trapping is generally considered the least stressful of the standard capture techniques for wild horses and has been utilized successfully since the early 2000s on the Big Summit Territory (Photo 10). The Comprehensive Animal Welfare Program Standards (USDI BLM, 2015) would be used as guidance during all gather operations (see Appendix 2). Use of helicopters, fixed-wing aircraft and motor vehicles would follow direction in 36 CFR 222, Subpart D, 222.64. These standards and direction have been developed to ensure that a safe and humane gather operation occurs and potential stress and injury to wild horses is minimized.

Photo 10: Wild horses in bait trap in 2010

A GAO Report, (GAO-09-77) dated October 2008, indicated for the 6 of 10 states reporting between 2005 and 2007 that BLM experienced a 1.2% death loss to wild horses as a result of gathers during that time.

Various impacts to wild horses from gather operations have been observed. Direct impacts include stress from capture, handling, sorting, and transportation. The intensity of these impacts varies by individual animal and methods, bait trapping being the least stressful. Post gather observations show that captured animals acclimate quickly to holding, becoming accustomed to water tanks, hay, and human presence.

An independent report prepared by four academia-based equine veterinarian or equine specialists, concluded "horses did not exhibit undue stress or show signs of extreme sweating or duress due to the helicopter portion of the gather, maintaining a trot or canter gait only as they entered the wings of the trap. Rather, horses showed more anxiety once they were closed in the pens in close quarters; however, given time to settle, most of the horses engaged in normal behavior...." (Greene, et al. 2010). Transport and sorting of captured animals is completed as quickly and safely as possible to reduce the occurrence of fighting, and to move animals to large holding pens so they can settle in with hay and water. During sorting and transport, animals may receive superficial wounds of the rump, face, or legs. Occasionally, an animal may make contact with trap and holding pen panels hard enough to sustain a fatal injury. Since 2002, there has been one horse death on the Ochoco (out of 52 horses captured) due to complications of bait trapping.

Indirect effects are those effects which are caused by the action that occur to individual horses later in time or further removed in distance but which are still reasonably foreseeable. These may include, miscarriages in mares, increased social displacement and conflict among stallions. It is extremely rare that mares have spontaneous abortions, especially during fall and winter gathers. Of the 52 horses that have been captured and removed from the Big Summit Territory by bait trap, one mare had complications with her pregnancy when she arrived at the Burns BLM short term holding facility. A veterinary check revealed that the mare had a dead foal inside of her. The veterinarian removed the dead foal but the mare died of complications from the procedure. Whether this incident was related to the gather is unknown. Conflicts among stallions may occur when an individual animal is sorted into the stallion pen. There may be a posturing and even a brief physical encounter that generally ends when one animal retreats. Such encounters usually result in bites and kicks and tend to be minor in nature. On rare occasions, an aggressive animal may continue to exhibit aggressive behavior beyond initial encounters. In such cases, the offending animal is often penned separately.

A small number of foals may be orphaned during gather operations, however use of bait trapping generally decreases the likely hood of this result. Orphaning may be a result of the mare rejecting the foal, the foal and mare becoming separated during gather operations, the mare dying or being euthanized during the gather, or other reasons. During bait trapping operations, the occurrence of orphaning foals is very limited because bands are typically captured together with limited handling. If a mare and foal are separated during the capturing process, the band is held in a safe area within the trap and the trap is reset to allow the band to be together.

Foals that are already orphans (prior to gathering) due to the mother rejecting it or dying from natural causes are rarely gathered. Orphans encountered during gathers are cared for promptly and rarely die or have to be euthanized.

It is anticipated that gathers will occur on the Big Summit Territory between October and March with October through December being the preferred period. At that time most foals would be between 5 and 8 months of age, and ready for weaning from their mothers. At this age the foals would be of such a size and stature as to reduce the probability of their accidental injury from other horses in the trap.

In accordance with Forest Service policy (FSM 2265.61), animals that are severely injured or seriously ill will be immediately destroyed in the most humane manner possible under the supervision of a Forest officer delegated such authority. Humane euthanasia of an animal as an act of mercy is fully documented by the person who destroys the animal.

Effects from Gather of Excess Wild Horses (Helicopter)-All Alternatives

While bait trapping is the preferred method of capture, helicopter assisted gather method of capture is also included as part of all Alternatives. Helicopter assisted gather has been used on the Big Summit Territory in the past with limited success. However, there could be a change in the environment, like a wildfire that removes all tree canopy, or a change in methods that would increase the success of helicopter assisted gathering on the Big Summit Territory, therefore, it is included as a part of all Alternatives. The USFS and Contractor would implement the most current approved Standard Operating Procedures (SOPs) (refer to Appendix 2 for the SOPs currently in effect). The SOPs have been developed to ensure that a safe and humane gather operation occurs and potential stress and injury to wild horses is minimized.

Helicopter assisted trapping requires erecting temporary traps, wings and holding facilities constructed of metal panels. As animals concentrate within each trap or holding facility, the mechanical disturbance associated with their hoof movement results in mortality and possible elimination of all vegetation. Prior to construction and use, all potential traps sites, wings and holding facilities, an IDT review and recommendation would be identified and approval by the authorized Forest officer.

A GAO Report, (GAO-99-77) dated October 2008, indicated for the 6 of 10 states reporting between 2005 and 2007 that BLM experienced a 1.2% death loss to wild horses from accidents during gathers and those euthanized for various reasons. This data shows that the use of helicopters and motorized vehicles has proven to be a safe, humane and effective means for the gather and removal of wild horses from public lands. In order to avoid negative impacts to pregnant mares, the agencies (BLM and USFS) avoid helicopter gathering during the six weeks prior and the six weeks following the peak of foaling (i.e., no helicopter assisted gathers are conducted during March 1 through June 30).

Various impacts to wild horses from gather operations have been observed. Direct impacts include stress from capture, handling, sorting, and transportation. The intensity of these impacts varies by individual animal. Post gather observations show that captured animals acclimate quickly to the holding corral situation, becoming accustomed to water tanks and hay, and human presence.

Injuries resulting from helicopter gathers include nicks to the face, legs or body from tree limbs while being herded by the helicopter. During gathering operations, animals will rarely encounter barbed wire fences that may result in wire cuts. These injuries are not fatal and can be treated at the trap site or temporary holding facility with medicinal spray until a veterinarian examines the animal. These types of injuries are minimized by conducting gathers in accordance with the current SOPs.

An independent report prepared by four academia-based equine veterinarian or equine specialists, concluded "horses did not exhibit undue stress or show signs of extreme sweating or duress due to the helicopter portion of the gather, maintaining a trot or canter gait only as they entered the wings of the trap. Rather, horses showed more anxiety once they were closed in the pens in close quarters; however, given time to settle, most of the horses engaged in normal behavior...." (Heleski, et al. 2010).

Though some members of the public deem helicopter removals inhumane, most documented injuries have occurred once the animals are captured, not during the helicopter gathering operation. Similar injuries would be expected during bait and water trapping as animals would still need to be sorted, aged, transported and otherwise handled.

Indirect effects are those effects which are caused by the action that occur to individual horses later in time or further removed in distance but which are still reasonably foreseeable. These may include miscarriages in mares, increased social displacement and conflict among stallions. It is extremely rare that mares have spontaneous abortions, especially during late summer and fall gathers. Conflicts among stallions may occur when an individual animal is sorted into the stallion pen. There may be a posturing and even a brief physical encounter that generally ends when one animal retreats. Such encounters usually result in bites and kicks that tend to be minor in nature. On rare occasions, an aggressive animal may continue to exhibit aggressive behavior beyond initial encounters. In such cases, the offending animal is often penned separately.

A small number of foals may be orphaned during gather operations, this may be due to the mare rejecting the foal, the foal and mare becoming separated during gathering or sorting, the mare dying or being euthanized during the gather, or other reasons.

Foals that are already orphans (prior to gathering), due to the mother rejecting it or dying from natural causes are rarely gathered. Orphans encountered during gathers are cared for promptly and rarely die or have to be euthanized.

It is anticipated that helicopter assisted gathers will occur on the Big Summit Territory between August and October with September/October being the preferred period. At that time most foals would be between 4 and 5 months of age, and ready for weaning from their mothers. At this age the foals would be of such a size and stature as to reduce the probability of their accidental injury from other horses in the trap.

In accordance with Forest Service policy (FSM 2265.61), animals that are severely injured or seriously ill will be immediately destroyed in the most humane manner possible under the supervision of a Forest officer delegated such authority. Humane euthanasia of an animal as an act of mercy is fully documented by the person who destroys the animal.

Effects to Herd Social Structure-All Alternatives

Horses are highly social animals with a strong mother-infant bond (National Research Council, 2013). Wild horse bands form complex social structures but this structure is often unstable. Berger (1986) found that although older females showed greater stability relative to younger females, less than 50% of the older females remained with the original band females during his 5 year study of wild horses in the Granite Range of Northern Nevada. Additionally he found that for stallions, tenure averaged only 3.16 (+/- 1.98) years. This data indicates that band social structure is not a static condition and, in fact, can be very dynamic. Personal observations of the bands in the herd on Big Summit Territory are consistent with these findings showing the social interaction of horses in the territory to be very dynamic and ever-changing with no clear pattern or correlations.

All alternatives have the potential to disrupt the social structure of individual bands of wild horses to some degree. Such disruption could be caused by the potential for gathering only a portion of a band, turning back individual mares after fertility control treatments as well as for other reasons. Bait trapping operations can be used to increase the likelihood of capturing the entire band over time if that is the desire.

Annual gathers would be necessary under Alternative 1 and may be necessary for Alternatives 2 and 3. These annual gathers have the potential to disrupt the social structure of some individual bands every year (depending upon trapping locations selected). The initial effects for Alternatives 1 and 2 would be high because of the high number of horses needing to be removed to get to AML. Once AML is achieved for both Alternatives 1 and 2, the smaller number of animals gathered each year under these Alternatives would result in a minimal effect to the individual bands. Mixing of social bands can also improve the genetic diversity of the herd once the observed heterozygosity is above the critical level.

Effects to Wild Horses Removed from the Big Summit Territory

All alternatives include varying degrees of gather and removal of excess wild horses from the Big Summit Territory. Wild horses removed from the Big Summit Territory would be transported to a short-term holding facility in trailers. All vehicles and trailers used in the transport of wild horses would be inspected prior to use to minimize injury during transport. Because bait trapping usually captures one band at a time, transportation of the band together would be done to the extent possible.

Time restriction for transporting animals to a short-term facility is limited to a maximum of ten hours, which is more restrictive than Manual policy, although in almost all cases the actual amount of time in a trailer is much shorter. During transport, potential impacts include stress, slipping and falling, and kicks and bites from other animals. If animals are in extremely poor condition, there is potential for individuals to die during transport, however this is extremely rare; since 2002, there has been one minor injury of a horse being transported to the Burns BLM short-term facility (out of 52 horses captured).

Upon arrival at the short-term facility, animals are off-loaded by trailer compartment and put into pens with good quality hay and water. Most animals settle down quickly and begin eating hay and drinking water. A crew inspects animals as they arrive and those with injuries are treated. Those with more than minor injuries or that are in a very thin condition are put into "sick" pens and cared for separately. Any animals with a chronic or incurable disease, or those with serious physical defects (such as tooth loss or excessive wear, club foot, or other deformities) would be humanely destroyed in the most humane manner possible under the supervision of a Forest officer delegated with such authority. Humane euthanasia of an animal as an act of mercy is fully documented by the person who destroys the animal.

After recently captured animals become acclimated to the facility, they are prepared for adoption or sale. The preparation includes pulling hair for genetic monitoring, vaccinations, boosters, identification, castration of males and deworming. Injuries or death resulting from preparation activities are rare but can potentially occur.

Forest Service policy allows placement of excess animals with qualified individuals, Government agencies, or other entities, as long as there is a written agreement. Individuals are allowed to adopt no more than four animals per year, unless the applicant is found capable of caring for more than four animals. Individuals adopting animals are subject to terms relating to humane treatment and care. This is the preferred method of handling excess animals that have been removed from the Big Summit Territory.

Animals that meet the sale-eligibility criteria would be offered for sale. Animals must meet the sale-eligibility criteria under the WFRHB Act of 1971, Pub. L. 92-195, 1333 (e) 2004. While the Act as amended only addresses sale without limitation, subsequent enactment of riders prohibiting the BLM's and Forest Service use of appropriated funds for the sale or slaughter of wild free-roaming horses and burros resulted in BLM's construction of a sale with limitation whereby purchasers declare in their purchase application to, "… not sell or transfer ownership of any such animals that I purchase to any person or organization that intends to resell, trade, or give away such animals for processing into commercial products." While current Forest Service policy is to follow the mandates of the Act as amended, it will comply with appropriations language limitations. Sales of excess wild horses without limitations, would be similar to the majority of livestock sales in the state whereby the owner has ultimate determination of the future use of the animal within the restrictions of state animal treatment and care laws. Sales of excess wild horses with limitations similar to those declared in the application to purchase BLM horses and burros would be expected to prevent the transfer of animals that previously had status as wild horses or burros for processing into commercial products. Under both types of sales, once sold, horses lose their protected status under the Act (16 U.S.C., Chap 30, §1333(e) (4)).

As a last resort, following Forest Service policy and in compliance with the WFRHBA, excess horses for which there is no adoption or sale demand would be destroyed in the most humane and cost efficient manner possible (36 CFR 222.69 (5)).

Effects to Wild Horse with the Emergency Action Framework

For all alternatives, an Emergency Action Framework will be used to help guide decisions. This framework will be anchored under the values of:

- Humane treatment of wild horses (36 CFR 222 Subpart D defines both the terms "humane" and "inhumane" and the context of their appropriate usage as relates to wild horses and burros")
- Long-term well-being of the wild horse herd
- Honor and maintain the "wildness" of the herd

The implementation of an Emergency Action Framework anchored in the above values will provide a framework to ensure that wild horses are humanely treated and will decrease any unnecessary suffering.

Cumulative Effects common to all Alternatives

There are several ongoing vegetation management projects that overlaps or borders the Big Summit Territory (see Table 16). In general, activities in these projects include ongoing pre-commercial thinning and fuels management. Both pre-commercial thinning and prescribed burning will most likely reduce available forage for the first year or two, but after recovery, forage will increase. These activities would increase access and availability of upland forage for wild horses in the long-term (post 2 years), riparian forage would receive less grazing pressure long-term until the upland forage is out-competed by the overstory. With the fuels management activities, in the short-term (less than 2 years) upland forage may be reduced putting more pressure on riparian areas temporarily. Treatments will take place in a mosaic pattern and over a time span so short term loss of forage will be minimal and should have little to no negative impact on the wild horse herd helping achieve a Thriving Natural Ecological Balance (TNEB). Wild horses would not be fed due to any pre-commercial or prescribed burning activities and the short-term reduction in available forage.

During vegetation management activities it is possible that individual groups of wild horses will temporarily move within the Big Summit Territory as a result the presence of increased numbers of people and noise in activity treatment areas. This movement to avoid disturbance is expected to be minimal due to the fact that all activities will take place in a mosaic pattern and over the span of several years. There have been no documented incidents of wild horses being injured as a result of any vegetation management activities that have occurred in the Big Summit Territory thus far and we do not expect any in the future because wild horses tend to avoid activity treatment areas during operations.

Ongoing noxious weed treatments are occurring in the Big Summit Territory. These treatments are expected to improve both upland and riparian forage conditions and have a long term beneficial effect.

Table 16: Projects that Have Cumulative Effects to Wild Horses in the Project Area

Project	Activities	Year	Cumulative Effect
Canyon Fuels & Vegetation Management Project (ROD, 2010)	Pre-commercial thinning and prescribed burning.	Implementation	Both pre-commercial thinning and prescribed burning will most likely reduce available forage for the first year or two, but after recovery, forage will increase until canopy covers close and reduce upland forage production again (mid to long term). Activities will take place in a mosaic pattern over several years minimizing short term loss of forage resulting in

Project	Activities	Year	Cumulative Effect
			minimal to no negative impact on wild horses.
Howard Elliott Johnson Fuels & Vegetation Management Project (ROD, 2011)	Pre-commercial thinning and prescribed burning.	Implementation	Both pre-commercial thinning and prescribed burning will most likely reduce available forage for the first year or two, but after recovery, forage will increase until canopy covers close and reduce upland forage production again (mid to long term). Activities will take place in a mosaic pattern over several years minimizing short term loss of forage resulting in minimal to no negative impact on wild horses.
Invasive Plant Treatments FEIS (ROD, 2012)	Reduces the extent of specified invasive plant infestations at identified sites and protects areas not yet infested from future introduction and spread.	Implementation	Long-term beneficial effect. Improves both upland and riparian forage.
Powerline Maintenance	Maintenance includes removal of trees near powerlines.	Ongoing	Forage will increase until canopy covers close and reduce upland forage production again (mid to long term). Activities will take place in a mosaic pattern over several years minimizing short term loss of forage resulting in minimal to no negative impact on wild horses.
Blue Mountains Forest Resiliency Project	Pre-commercial thinning and prescribed burning.	Planning	Both pre-commercial thinning and prescribed burning will most likely reduce available forage for the first year or two, but after recovery, forage will increase until canopy covers close and reduce upland forage production again (mid to long term). Activities will take place in a mosaic pattern over several years minimizing short term loss of forage resulting in minimal to no negative impact on wild horses.

Alternative 1 – No Action

Forage Availability

The AML for Alternative 1 will remain 55-65. This alternative is expected to result in a forage shortfall within the wild horse winter range during winters of above average snowfall when the horse herd is above 57 head. This in turn is expected to result in exceedance of LRMP allowable use standards in riparian areas within the wild horse winter range. Table 17 below displays the anticipated forage shortfall under this alternative:

Table 17: Alt. 1 Forage Availability based on Species Needs

Animal Needs	Providing for all species	Wildlife Needs provided outside Big Summit Territory
Permitted Sheep forage needs	160,875 lbs.	160,875 lbs.
Elk forage needs	155,506 lbs.	0 lbs.
Deer forage needs	11,778 lbs.	0 lbs.
Wild Horse forage needs (65)	241,540 lbs.	241,540 lbs.
Total Forage Needs	569,699 lbs.	402,415 lbs.
30% Allowable forage availability	372,160 lbs.	372,160 lbs.
Forage balance	-197,539 lbs.	-30,255 lbs.
Projected winter range riparian use levels	46%	32%

Under the existing condition, with current AML, there is a forage shortfall of by 197,539 lbs. Even assuming that wildlife would move to other areas during winters with above-average snow fall (approximately 110% or more snowfall), there would still be a forage shortfall of 30,255 lbs. (Table 16). Both scenarios are expected to exceed the Forest Plan allowable use standard and guideline at the high AML for this Alternative, the low AML of 55 horses is expected to have a projected winter range riparian use of 43% with wildlife and 29% without.

Again, these calculations are based on winters with above average snowfall which does not occur every year so the exceedance of the Forest Plan allowable use standard and guideline and the shortfall in forage production would not be expected to occur every year, but would be expected to occur periodically. These periodic levels of exceedance would be expected to slow or stall riparian forage condition recovery.

Data collected in the wild horse winter range in the falls of 2017 and 2018 showed riparian utilization levels ranging from just under 60% to approximately 80% with evidence of wild horses being the primary contributor of utilization. In fact, in 2018 when riparian utilization levels ranged from just under 60% to just under 80%, domestic sheep did not graze in the area. These levels of utilization may have a long-term effect on the quality and availability of riparian forage depending upon timing and species grazed (Holechek et al., 2000). For most graminoid species, if the plants are continuously heavily utilized, the vigor of the plants is decreased and over time other more grazing resistant plants can replace these species, as grazing resistant plants become relatively more competitive for resources under that degree of grazing pressure (Holechek et al., 2000). This level of riparian utilization is of even more importance when considered in the context that wild horses show a marked preference for riparian areas for grazing, and apparent trends make restoration of unsatisfactory riparian conditions doubtful (Clary & Leininger, 2000).

The WFRHBA requires minimal feasible management when dealing with wild horse, therefore, we expect localized exceedance of allowable use standards on riparian areas within the Territory even when horse numbers are within the range of 55-65 AML. However, the expectation is that these localized exceedances of the allowable use standard and guideline will shift in location from one year to the next minimizing riparian species composition drift from grazing pressure. This shifting of areas where utilization exceeds the allowable use standards and guidelines from one year to the next is also expected to minimize the negative effects of this disturbance on stream bank dynamics. However, as horse numbers climb above the range of AML (like the current number of 135 is) the extent of riparian areas where utilization exceeds the allowable use standard and guideline will increase and the probability that any given riparian area will receive use levels that exceed the allowable use standard and guideline over multiple years will increase as well. Repeated exceedance of the allowable use standard and guideline, when over upper AML of 65, over multiple years increases the probability that this and associated disturbance will result in negative impacts to long term riparian conditions.

The current horses numbers are at least 135, with the population control tool of only capture and removal, it is estimated that it may take up to 10 years to achieve the AML of 55-65 for this Alternative. Until then, there will be continued short-term effects for upland forage and long-term effects for riparian forage.

Genetic Health

Alternative 1 does not provide any tools for managing the genetic health of the Big Summit Territory horses but only allows for the progress of natural selection. Under this Alternative, the existing observed heterozygosity of 0.65 and 0.58 from two samples (Cothran, 2011) will remain below the recommended critical level of 0.66 (USDI, BLM, 2010). This indicates that the genetic variability of the herd is low. Low genetic variability can lead to poorer overall health and vigor of the herd and loss of adaptability in the long run (Cothran, 1991). Because Alternative 1 does not include any management tools to address genetic health, genetic depression is expected to continue to occur and the fitness of the herd is expected to continue to decline. As a result, the observed heterozygosity would likely fall lower than the values most recently measured. This could lead to lower birth rates, increased mortality and the decreased ability to adapt to environmental changes (Cothran, 2000) for the wild horse herd on Big Summit Territory.

Population Growth Control

The only management controls of population growth included under Alternative 1 are the capture and removal of excess wild horses. Excess wild horses will be determined in accordance with the WFRHBA based on the comparison of the current inventory to the AML range of 55 to 65 and/or other criteria found in the WFRHBA and Forest Service regulations (36 CFR 222 Subpart D).

Bait trapping is expected to be the primary gather method for capture and removal of excess wild horses although other capture methods like helicopter assisted gathering can be used. Based on the current inventory (Owyhee Aerial Research Inc., 2018) of 135 horses, under Alternative 1 there would be at least 70 excess horses if this Alternative is selected. Consecutive gathers to remove the excess wild horses would begin as soon as possible based on budget and resource availability. First priority would be for gathers of excess wild horses residing outside of the Territory. A selection criteria for removal may be used based on age class. These horses would be gathered and transported to a BLM facility, Forest Service facility or leased private facility where they would be prepared for adoption or sale. Once AML is reached, population growth rates could reach up to 20% annually and maintenance gathers are expected to occur annually or bi-annually with approximately 11-26 horses removed. The number of excess wild horses to be gathered annually or bi-annually will be based on the current inventory number and how many horses are above the AML range.

For Alternative 1, the only tool available to control population growth and maintain the AML is capture and removal of excess wild horses. As discussed above, the initial capture needs will be much higher because of the difference between the current inventory of horses (135) and the AML range of 55-65, at least 70 excess horses would need to be removed as soon as budgets and resources allow. Once the AML range is achieved, continued maintenance gathers are expected to occur every year or two with a range of approximately 11-26 horses needing to be removed. Refer to the discussion above for the direct effects to wild horses for actions taken in capture and removal including effects to horses by gathering with bait trap or helicopter, effects to the herd social structure and the effects to horses once removed from the Territory.

Cumulative Effects

See the previous discussion of cumulative effects common to all alternatives.

The focus of this cumulative effects discussion is on winter range forage utilization and competition for that forage. Wild horses, permitted livestock and wildlife species all compete for available forage within the Territory. From mid-June to the end of September there are two bands of sheep permitted to graze on allotments that overlap with the Big Summit Territory. Forage competition for upland and riparian forage occurs between sheep and horses although dietary overlap between the two species in the summer time is small, sheep prefer forbs while horses prefer grasses. One study looked at the dietary overlap of pronghorn sheep and horses and found a summer overlap of only 7% (McInnis and Vavra, 1987) while another found a 21% dietary overlap in the summertime between wild horses and domestic sheep (Olsen and Hansen, 1977). Specifically, one band of sheep spends approximately 19 days in June grazing in the wild horse winter range. Permitted sheep use was voluntarily decreased because of a lack of forage (see Range Resource Report) from

2017-2019. The last ten years of stubble height measurements in the DMAs inside the winter range all exceed twelve-inches which show light utilization by sheep in the winter range. Specifically, wild horse winter range riparian utilization monitoring done in the fall of 2017 (sheep present) and 2018 (sheep not present) show a difference of at the most 13%, suggesting that sheep utilization in the winter range is around 13%.

In addition to permitted livestock, wildlife species, specifically elk and deer compete with wild horses for forage in the Territory. Dietary overlap is greatest between elk and horses (Hosten, 2007, Salter and Hudson, 1980). The current population levels for both elk and deer, while still below the Management Objectives, are higher than when the 1975 plan was developed. The Act limits agency authority to manage for horses where they occurred at the time of enactment. Therefore, the Territory must supply the complete forage needs for the horses year-round while elk and deer are free to roam to adjacent lands (see Wildlife Resource Report).

In Alternative 1, the AML would remain the same as established in 1975 at 55-65 horses. Riparian utilization levels at this AML when combined with the use of permitted livestock and wildlife will remain at the same level. Utilization monitoring data in three sites in the winter range prior to 2010 when this AML was managed for, has consistently been below 30% utilization with one exception. If the Forest Plan allowable use standard is exceeded in the riparian areas of the wild horse winter range or there is an above average snowfall, it will be more difficult for horses to maintain desirable body condition levels (above Henneke Body Score 2) through the winter. As body conditions decline other health and reproductive issues increase such as foal miscarriage or contraction of viral or bacterial infections. Until horse numbers reach the 55-65 AML, which may take up to 10 years, exceedance of the Forest Plan allowable use levels in riparian areas will continue and is expected to prevent recovery of riparian areas in unsatisfactory condition.

Forage utilization may also have a cumulative impact on riparian resource conditions. While the Forest Plan allowable use standard and guideline for riparian communities in unsatisfactory condition is up to 30% of combined permitted livestock, wildlife and wild horse use in the Territory, there is more forage available so exceedance of this standard and guideline is expected to occur on occasion especially since riparian areas are preferred habitat for horses and we have minimum feasible management practices (WFRHBA) so herding or other management practices to move horses out of riparian areas will not occur. Therefore, repeated utilization exceedance over time increases the likelihood or probability of decline of the competitive advantage of species sensitive to grazing which in turn can result in species composition shift and ultimately riparian condition remaining in unsatisfactory condition.

In summary, the focus of the cumulative effects analysis for Alternative 1 is on competition between wild horses, permitted livestock and wildlife for winter range forage and the resultant expected levels of utilization. At the established AML of 55-65, upland and riparian range conditions are expected to remain the same, however, vegetation management projects are expected to temporarily improve upland forage conditions. The competition for forage on wild horse winter range has increased since the AML was established in 1975, especially between wild horses and wildlife. As the demand for forage has increased and upland and riparian range conditions have declined over time it is expected that the Forest Plan allowable use standard and guideline for riparian areas will be exceeded more often across more riparian communities within the wild horse winter range. This is expected to shift the competitive advantage of some grazing sensitive riparian species preventing riparian condition recovery. During winters with above average snowfall, unsatisfactory range conditions can result in a forage shortfall that may be reflected in poorer wild horse body conditions and associated reproductive and health issues.

Alternative 2 – Direct, Indirect, and Cumulative Effects

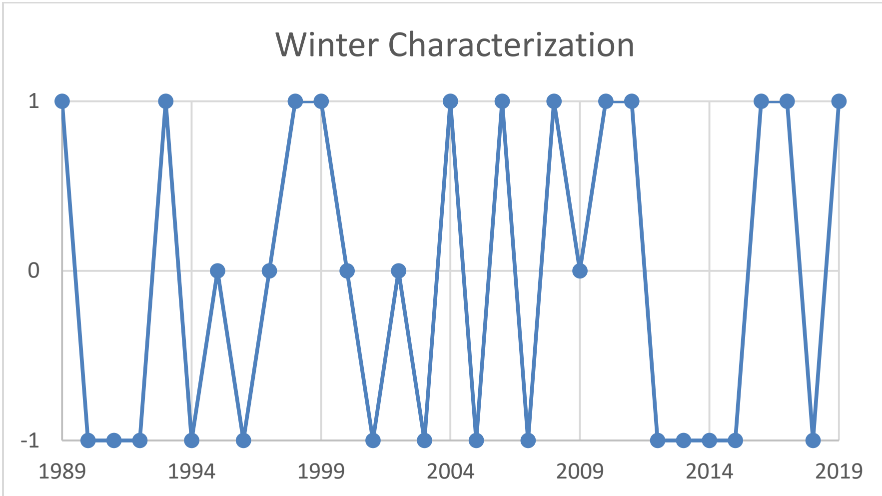
Forage Availability

The AML for Alternative 2 would be 12-57. This AML was based on the process described in the BLM Handbook 4700-1 for wild horses (see AML Analysis), and was calculated based on the most limiting factor of winter range forage availability during winters of above average snowfall inside the Big Summit Territory. It also considered the Forest Plan riparian allowable use level of 30 percent due to the existing unsatisfactory conditions of riparian communities within the wild horse winter range. The wild horse winter range was based on winters of above-average (greater than 110 percent) snowfall (see Graph 3 for years of above-average snowfall). The high AML also considers expected wildlife behavior during winters of above average snowfall when big game is expected to move to other areas that provide better winter habitat. Table18 below displays the anticipated forage shortfall under this alternative.

Table 18: Forage Availability Low and High AML

Animal Needs	Providing for all wildlife species needs	Wildlife needs provided outside of Big Summit Territory
Permitted Sheep forage needs	160,875 lbs.	160,875 lbs.
Elk forage needs	155,506 lbs.	0 lbs.
Deer forage needs	11,778 lbs.	0 lbs.
Wild Horse forage needs	44,592 lbs. (12 horses)	211,812 lbs. (57 horses)
Total Forage Needs	372,751 lbs.	372,687 lbs.
30% Allowable forage availability	372,160 lbs.	372,160 lbs.
Forage balance	-591 lbs.	-527 lbs.
Projected winter range riparian use levels	30%	30%

Graph 3: Above and Below Average winter snow-fall



Bringing the Big Summit Territory's wild horse numbers to within the range of 12-57 is expected to facilitate minimum feasible management of wild horses during most conditions that occur in the Territory. The current inventory indicates that at least 135 horses occupy the area within and around the Big Summit Territory. Until horse numbers are brought within AML it is expected that the Forest Plan allowable use levels will be exceeded in riparian communities within the Territory. For most graminoid species, if the plants are continuously heavily utilized, the vigor of the plants are decreased and over time other, more grazing resistant plants, can replace these species as grazing resistant plants become relatively more competitive for resources under that degree of grazing pressure (Holechek et al., 2000). Current unsatisfactory conditions in riparian areas would not be expected to improve in the short-term. With the greater diversity of tools available for use under Alternative 2, it is estimated to take up to 5 years to reach AML. It is expected that the Forest Plan allowable use standard and guideline will continue to be repeatedly exceeded on riparian areas within the wild horse winter range until AML is reached.

Once the AML is within the range (in up to 5 years) given the common wild horse population growth rate of 20 percent, around 10 head of horses would need to be captured annually or 20 to 25 head of horses would need to be captured every other year to maintain AML if fertility control methods are unsuccessful at reducing population growth rates, which is not expected. Since the bait trap method is the most effective and efficient capture method (as well as the least stressful on wild horses) because of Big Summit Territory's difficult terrain, capture will be conducted every year or every other year in order to balance resource capacity with the minimum feasible management goal from the Act. The goal for AML would not be to get to the low AML of 12 every 1-4 years, but rather to plan bait trap gathers every year or every other year to maintain the high AML(see Appendix B for AML Analysis details).

Genetic Health

The proposal for management of genetic diversity under Alternative 2 is to manage for an acceptable level of observed heterozygosity which is above the critical level of 0.66 (USDI, BLM, 2010). The observed heterozygosity for the herd would be increased by the translocation of genes through importing wild horse mares from source herds as recommended by genetics experts. The National Research Council recommends that groups of HMAs (Territories) constitute a single population and manage them by using natural or assisted migration (translocation) whenever necessary to maintain or supplement genetic diversity (National Research Council, 2013). Initially, it may take translocation of several mares to get the observed heterozygosity above the critical level of 0.66 because most recent monitoring indicates that it is below that critical level, at 0.65 and 0.58 (Cothran, 2011). Observed heterozygosity will be monitored by collecting DNA-based samples at gathers and having them analyzed by genetic experts. Monitoring reports and translocation recommendations will be requested from genetic experts with access to an adequate wild horse genetic database from which to make such recommendations, Texas A & M University is an example. Once monitoring indicates observed heterozygosity is above the critical level for this herd, the threats of low genetic variability such as overall health and adaptability will be decreased. However, genetic variability will require continuous management and will continue to be monitored with translocation of genes imported as recommended by genetic experts. This Alternative will have a positive effect on the genetic variability of the wild horse herd in the Big Summit Territory and will promote managing the horses in a thriving natural ecological balance.

Population Growth Control

Under Alternative 2, population growth will be controlled through capture and removal of excess wild horses and implementation of fertility control measures. The combination of both of these tools will have the greatest effect for achieving and maintaining AML with the minimal feasible management required by the WFRHBA.

Excess wild horses will be determined in accordance with the WFRHBA based on the current inventory or other criteria found in the WFRHBA. Bait trapping will be the primary gather method for capture and removal of excess wild horses. Based on the current inventory (Owyhee Aerial Research Inc., 2018) of 135 horses, under Alternative 2 there would be at least 78 excess horses if this Alternative is selected. Consecutive gathers to remove the excess wild horses would begin as soon as possible following a decision as limited by budget, resource availability and weather. Wild horses residing outside of the Territory will have highest priority for capture and removal of excess wild horses. Age class can also be used as a criteria for capture and removal. These horses would be gathered and transported to a BLM facility, Forest Service facility or leased or contracted private facility where they would be prepared for adoption or sale.

Under Alternative 2, fertility control measures would be implemented once AML is reached but might also be in conjunction with capture and removal to within the AML range if genetic health recommendations align. These measures would be used to slow population growth however, the capture and removal of excess animals to within the range of AML would be highest priority. Fertility control measures would be implemented: on horses that are gathered and released, or by remote darting. Implementation of fertility control measures would suppress population growth and which would reduce how many horses would need to be gathered over time. Fertility control would be conducted in accordance with the Standard Operating Procedures (SOPs) described in Appendix 4. All fertility control methods recommended by the Wild Horse and Burro Advisory Board and approved for equine use by the EPA, FDA, or other governmental regulatory body, may be used, including contraception tools and sterilization tools as well as sex ratios.

Contraception tools recommended by the Wild Horse and Burro Advisory Board and approved by the EPA, FSA, or other governmental regulatory body will be administered as soon as possible by trained personnel, either in conjunction with achieve AML or once AML is achieved (in up to 5 years). Fertility control measures may include application of Porcine Zona Pellucida (PZP, trade name Zonastat-H) or GonaCon but is not limited to these two drugs. Applications would be recorded, and treatments would be monitored to attempt to match the estimated population growth to achieve a stable herd size within AML and minimize the need for gathers. The ability to achieve this depends on the Forest capacity, available resources and opportunities for treatment in the Big Summit Territory. The BLM conducted a literature review and effects discussion (Appendix 3), a summary of effects is described below, more details can be found in Appendix 3.

In March of 2016, a PZP trial was conducted in the Big Summit Territory with the objectives of testing the feasibility of PZP field treatments, the efficacy of PZP treatments, efficiency and safety of administration of PZP and the economic sustainability of PZP treatments. Two types of field treatment methods were tested, trapped horses and untrapped horses, to determine the efficacy of each method. A band of eight horses was trapped in March and six mares were treated with the initial and booster treatments of PZP required for effectiveness. These trapped horses were held in the trap for three weeks and humanely cared for until the booster could be administered and horses were released. That same year, a total of sixteen days were spent locating and administering the initial PZP treatments to seventeen mares and booster treatments to five mares. Twelve mares of the ones that received the initial treatment were never given the booster treatment of PZP because they could not be relocated. The application of only the initial treatment on these mares had no effect on their reproductive success. Mares that were already pregnant in 2016 had their foals with no observed effects to the foals. Of the eleven mares treated by both methods with the initial and booster, none of the mares had foals in 2017. In 2018, of those eleven mares treated with both the initial and booster, three had foals which is a reproductive rate of 18% for this sample size. The only observed adverse effect of the PZP trial was the development of a small granuloma on the hip of one mare where the PZP was administered.

When administered, the PZP (antigen) causes the mare's immune system to produce antibodies that bind to the mare's own eggs, effectively blocking sperm binding and fertilization (Science and Conservation Center, 2013). PZP is relatively inexpensive, safe for mares and the environment, and can be easily administered in the field once horses are located. The PZP contraceptive also appears to be completely reversible. The administration of the vaccine is limited to those specifically trained to handle, mix and deliver the product.

Kirkpatrick et al., 2012 established that PZP administered to pregnant mares has no effect on the fetus and the mare will carry and give birth to a foal as normal. The vaccine has also been shown to have no apparent effects on the health of the offspring, or behavior of treated mares (Turner et al., 1997).

GonaCon™ is another fertility control vaccine that received EPA approval for use on wild horses and burros (February 13, 2013). The vaccine works by simulating the production of antibodies that bind to the gonadotropin- releasing hormone (GnRH) in the animal's body. GnRH signals the production of sex hormones (e.g., estrogen, progesterone and testosterone). By binding to GnRH, the antibodies reduce GnRH's ability to stimulate the release of these sex hormones. All sexual activity is decreased, and animals remain in a non-reproductive state as long as a sufficient level of antibody activity is present. The product can be delivered by hand injection, jab stick, or darting.

From a study completed at the Nevada State Penitentiary, Carson City, NV, by Killian, et al (2006) it was reported that the efficacy of GonaCon™ was 94% for the first breeding season, 60% during the second breeding season and 53% during the third year. These data show that the efficacy of GonaCon™ is higher than published research regarding PZP. Another difference found is that while PZP does not inhibit breeding behavior, GonaCon™ decreases breeding activity.

Fertility control tools may also include permanent sterilization of wild horses. The current (recommended by the Wild Horse Advisory Board) sterilization procedures conducted is castration of studs done at a facility and then returned to the Territory. The National Research Council recommends that one of the three most promising methods of fertility control is chemical vasectomy (National Research Council, 2013) but discusses the limitations with chemical vasectomies because the effects of the permanent sterilization of studs will be self-corrected by younger studs rising through the ranks. However, there are tools and models developed to help consider sterilization to promote or maintain genetic diversity. The USGS suggests that wild horse managers consider permanent contraceptive techniques, as long as results are monitored and adjustments are made if necessary (USGS, 2015). Sterilization would also decrease the need for annual application of fertility control and captures and removals which all add some level of stress to horses. Sterilization for horses on Big Summit Territory is a tool that would be considered for population growth control and/or helping improve genetic diversity.

For Alternative 2, in addition to capture and removal of excess wild horses, fertility control tools such as contraceptives and sterilization, will be used for population growth control. The initial capture needs will be high because of the difference between the current inventory of horses (135) and the AML range of 12-57, at least 78 excess horses would need to be removed as soon as budgets and resources allow. Refer to the discussion under Effects from Gather of Excess Wild Horses (Bait Trapping)-All Alternatives, Effects from Gather of Excess Wild Horses (Helicopter)-All Alternatives, Effects to Herd Social Structure-All Alternatives, Effects to Wild Horses Removed from the Big Summit Territory and Effects to Wild Horse with the Emergency Action Framework for the direct effects to wild horses for actions taken. Once the AML range is achieved, continued maintenance gathers may occur every year or two with a range of approximately 11-26 horses needing to be removed or fertility control tools may change the number of horses in excess to the AML, ideally with little to no horses captured and removed.

Cumulative Effects

See the previous discussion of cumulative effects common to all alternatives.

The focus of this cumulative effects discussion is on winter range forage utilization and competition for that forage. Wild horses, permitted livestock and wildlife species all compete for available forage within the Territory. Permitted livestock grazing overlaps in the Big Summit Territory. From mid-June to the end of September there are two bands of sheep permitted to graze on allotments that overlap with the Big Summit Territory. Forage competition for upland and riparian forage occurs between sheep and horses although dietary overlap between the two species in the summer time is small, sheep prefer forbs while horses prefer grasses. One study looked at the dietary overlap of pronghorn sheep and horses and found a summer overlap of only 7% (McInnis and Vavra, 1987) while another found a 21% dietary overlap in the summertime between wild horses and domestic sheep (Olsen and Hansen, 1977). Specifically, one band of sheep spends approximately 19 days in June grazing in the wild horse winter range. Permitted sheep use was voluntarily decreased because of a lack of forage (see Range Resource Report) from 2017-2019.

In addition to permitted livestock, wildlife species, specifically elk and deer compete with wild horses for forage in the Territory. Dietary overlap is greatest between elk and horses (Hosten, 2007) (Salter and Hudson, 1980). The current population levels for both elk and deer, while still below the Management Objectives, are higher than when the 1975 plan was developed. The Act limits agency authority to manage for horses where they occurred at the time of enactment. Therefore, the Territory must supply the complete forage needs for the horses year-round while elk and deer are free to roam to adjacent lands (see Wildlife Resource Report).

In Alternative 2, the AML was calculated to be 12-57 horses (AML Analysis, Appendix 5). Riparian utilization levels at this herd size, when combined with the use of permitted livestock and wildlife, is not expected to repeatedly exceed 30% on the wild horse winter range, the level of expected utilization would depend primarily on whether big game resides on the Territory during winters of above average snowfall. Until horse numbers reach the 12-57 AML, which is estimated to take up to 5 years, because Alternative 2 also allows fertility control methods to slow population growth rates, exceedance of the Forest Plan allowable use levels in riparian areas will continue and is expected to prevent recovery of riparian areas in unsatisfactory condition. In addition, until AML is reached, it will be more difficult for horses to maintain desirable body condition levels (above Henneke Body Score 2) through the above average snowfall winters. As body conditions decline other health and reproductive issues increase such as foal miscarriage or contraction of viral or bacterial infections. Once the AML is reached, because of the increase in wildlife, in a below to average winter, exceedance of the Forest Plan allowable use levels could still occur, however, wildlife can roam outside of the Territory, where horses are required to remain inside the Territory year-round.

Forage utilization may also have a cumulative impact on upland/riparian resource conditions. While the Forest Plan allowable use standard and guideline for riparian communities in unsatisfactory condition is up to 30% of combined permitted livestock, wildlife and wild horse use in the Territory, there is more forage available so exceedance of this standard and guideline is expected to occur on occasion especially since riparian areas are preferred habitat for horses and we have minimum feasible management practices (WFRHBA) so herding or other management practices to move horses out of riparian areas will not occur. Therefore, repeated utilization exceedance over time increases the likelihood or probability of decline of the competitive advantage of species sensitive to grazing which in turn can result in species composition shift and ultimately riparian condition remaining in unsatisfactory condition.

In summary, the focus of the cumulative effects analysis for Alternative 2 is on competition between wild horses, permitted livestock and wildlife for winter range forage and the resultant expected levels of utilization. At the proposed AML of 12-57, riparian conditions will improve because of forage utilization levels of up to 30%. Until the AML is reached, in up to 5 years, it is expected that the Forest Plan allowable use standard and guideline for riparian areas will continue to be regularly exceeded particularly during winters of above average snowfall. During winters with above average snowfall, unsatisfactory range conditions can result in a forage shortfall that may be reflected in poorer wild horse body conditions and associated reproductive and health issues.

Alternative 3 – Direct, Indirect, and Cumulative Effects

Forage Availability

The AML for Alternative 3 would be 150-200. This AML was based upon public input which encouraged the agency to consider an alternative with this herd size as a way to address maintenance of genetic variability. Forage needs and the shortfall anticipated during winters of above average snowfall are calculated in the following Table 19:

Table 19: Forage availability based on sheep, and wild horse needs with big game staying in and leaving the territory during winters of above average snowfall.

Animal Needs	Providing for all species	Wildlife Needs provided outside Big Summit Territory
Permitted Sheep forage needs	160,875 lbs.	160,875 lbs.
Elk forage needs	155,506 lbs.	0 lbs.
Deer forage needs	11,778 lbs.	0 lbs.
Wild Horse forage needs (200)	743,200 lbs.	743,200 lbs.
Total Forage Needs	1,071,359 lbs.	904,075 lbs.
30% Allowable forage availability	372,160 lbs.	372,160 lbs.
Forage balance	-699,199 lbs.	-531,915 lbs.
Projected winter range riparian use levels	86%	73%

At an AML of 150-200 horses, a forage shortfall on the wild horse winter range would be expected to occur regularly during most winters (based on fall utilization measures taken in 2017 and 2018). The projected winter range riparian use levels would range from 58-71% at the low AML with and without wildlife winter needs provided for in the Territory to 73-86% use at the high AML. As a result, it is expected that utilization levels on riparian areas within the wild horse winter range will range from 60 to over 80 percent during winters of above average snowfall. It is anticipated that under this alternative the Forest Plan allowable use standard and guideline for riparian areas will be regularly exceeded in many of the riparian areas within the wild horse winter range regardless of snowfall.

Under this alternative even if all other grazing were eliminated (sheep and wildlife), contrary to direction in the act to maintain a “multiple-use relationship in the area”, a herd size of 150-200 would be expected to result in forage utilization measurements of 45-60% on riparian areas within the wild horse winter range during winters of above average snowfall. With a herd size of at least 135 head and the provision for other grazing use to occur to maintain a multiple use relationship in the area, utilization measurements on the wild horse winter range prior to winter in 2017 displayed riparian utilization levels that ranged from just over 70% to approximately 80%. While riparian utilization levels ranged from almost 60% to just under 80% in the fall of 2018 which included only wildlife use and use by a wild horse herd of at least 125 horses as the grazing allotment was voluntarily rested from permitted livestock use.

While the measured utilization levels in 2017 and 2018 occurred prior to winters of below average snowfall, the modeled calculations above are based on winters of above average snowfall which do not occur every year therefore the projected utilization rates should not be expected to occur every year, but would be expected to occur periodically. Drought conditions could produce lower levels of annual forage production than were considered in this analysis which could result in less forage availability once winter conditions evolve. With projected higher levels of utilization on a more regular basis, the extent of riparian areas where utilization exceeds the Forest Plan allowable use standard and guideline will increase and the probability that any given riparian area will receive use levels that exceed the allowable use standard and guideline over multiple years will increase as well. Repeated exceedance of the allowable use standard and guideline over multiple years increases the probability that this and associated disturbance will result in negative impacts to long term riparian conditions within the wild horse winter range inside the Big Summit Territory.

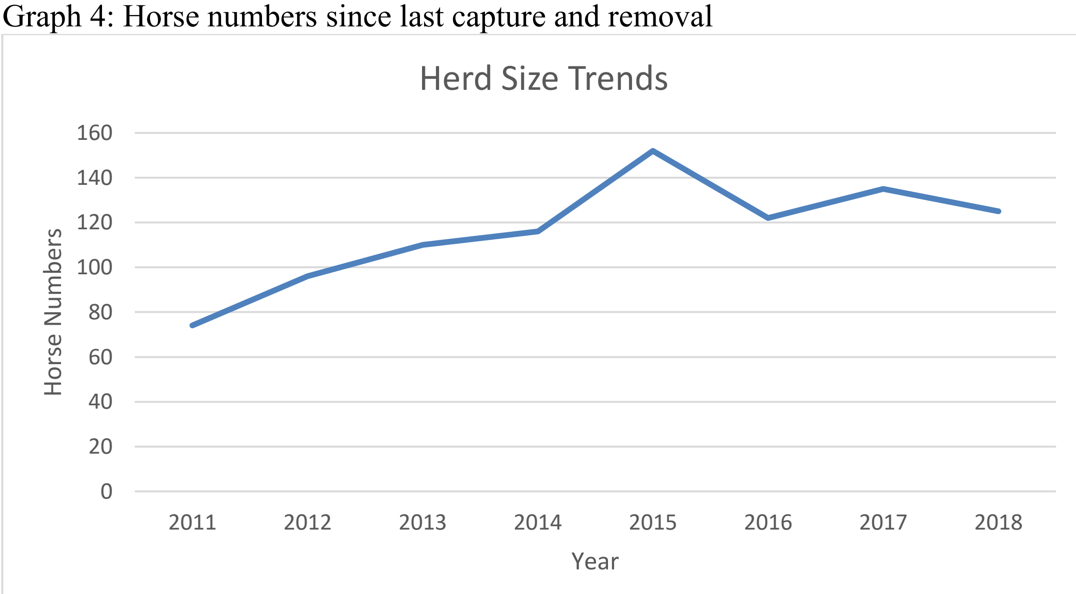
During the ground count inventories (held in June), in 2017 63 horses were counted in the base camp unit which represents the bulk of the wild horse winter range and 65 horses were counted in base camp unit in 2018. It was also noted that in 2018, the same bands counted in 2017 were the ones seen in 2018. The utilization measurements taken prior to the winter of 2017-2018 showed utilization levels of approximately 71-80% cumulative with the bulk of utilization occurring from horses (see Appendix 6 for photos). These levels of utilization (which fare exceed the Forest Plan riparian allowable use standard and guideline) occurred with minimum wild horse populations of 135 in 2017 and 125 in 2018, both of these population numbers are below the proposed AML for Alternative 3. Photo 11 below shows a spring that receives heavy use in the wild horse winter range, the photo on the left was taken in 2005 when the minimum horse numbers was 61 head. The photo on the right was taken in 2019 when the minimum horse numbers were 135 head. The AML of 150-200 horses will continue to exceed the Forest Plan allowable use standard and guideline for riparian communities which is expected to prevent recovery of unsatisfactory riparian conditions.

Photo 11: Spring photo point in wild horse winter range

2005 2019

Annual ground count inventories since the last wild horse capture and removal in 2010 showed an initial rapid increase in horse numbers followed by an apparent plateau in the number of horses associated with the Big Summit Territory (Graph 4).

Graph 4: Horse numbers since last capture and removal



This might suggest that there could be some self-limiting on herd size. The primary way that self-limiting occurs is with increased competition for forage at higher densities, which results in smaller quantities of forage per animal, poorer body condition and decreased natality and survival rates (National Research Council, 2013). The literature suggests that when self-limiting occurs in horse herds there will probably be an increased number of animals in poor body condition and high numbers of animals dying from starvation(National Research Council, 2013). While there is currently no evidence, other than an apparent plateaue in population growth, that shows an increase in horses in poor body condition or high numbers of horses dying in the Big Summit Territory, horse are moving further outside the Territory and measured forage utilization rates within the wild horse winter range and observed utilization rates throughout the Territory are very high. There have been a few incidences when horses have been monitored in the winter time for body condition, or removed due to poor body condition (see Photo 11). A self-limiting herd would not be considered to be in a thriving natural ecological balance and a herd size of 150-200 would require a higher intensity of management including capturing and removing horses in poor body condition and capture and transport of horses outside the territory back inside the territory. This would not be considered consistent with the direction of the Act for minimal feasible management.

Photo 11: Horse during winter in poor body condition

When horses move outside of the Territory, there is an increase in necessary management actions and concentration of resource damage. Horses outside of the Territory need to be relocated back inside either by physical movement usually on horseback or foot or by trapping and hauling to an area inside the Territory. If horses move to adjacent private land, the horses must be removed immediately when the Forest is requested to do so by the private landowners. The grazing allotments on adjacent National Forest System lands surrounding the Territory are all cattle allotments which have smaller fenced areas (pastures) than most sheep allotments have. Confinement of wild horse bands and their associated disturbances to these smaller areas tends to amplify the resource impacts by horses, especially in riparian areas.

Genetic Health

The AML for Alternative 3 is based on the public's request to analyze a population level of 150-200 wild horses because they desire to see an alternative analyzed that addresses maintenance of genetic variety through what they call this minimally viable herd size.. Genetics management of populations uses a concept called Minimum Viable Populations (MVP) (Cothran, 1991). MVP is the minimum number of breeding individuals that must be maintained for a population to survive a given time period (Cothran, 1991). Furthermore, Cothran suggests that in random mating populations, found in most mammalian species, the MVP should not be less than 50 individuals and with an AML of 150-200, there would be at least 50 breeding individuals to maintain genetic variability. However, since the wild horses in the Big Summit Territory are displaying genetic depression and associated low levels of heterozygosity, having an MVP of 50 or more individuals would not be expected to improve the observed heterozygosity to above the recommended critical level of 0.66 (USDI, BLM, 2010). In a letter dated July 16, 2009, Cothran states that enlarging a population's size does not increase the population's genetic variation, it only slows the rate of loss of existing variation (Cothran, 2009). The Big Summit herd already has a low genetic variability (Cothran, 2011, Mills, 2010). Because Alternative 3 does not include any actions to increase genetic variation, under this alternative the observed heterozygosity of the herd will continue to decline below the critical level and the fitness of the herd is expected to continue to decrease as well. This could lead to lower birth rates, increased mortality and a decreased ability to adapt to environmental changes (Cothran, 2000) for the wild horse herd on Big Summit Territory.

Population Growth Control

Under Alternative 3, population growth would be controlled through capture and removal of excess wild horses and implementation of fertility control measures. The combination of both of these tools will have the greatest effect for achieving and maintaining AML with the minimal feasible management required by the WFRHBA.

Excess wild horses will be determined in accordance with the WFRHBA based on the current inventory or other criteria found in the WFRHBA. Bait trapping will be the primary gather method for capture and removal of excess wild horses. Based on the current inventory (Owyhee Aerial Research Inc., 2018) of 135 horses, under Alternative 3 current horse numbers are below the AML and no capture and removal or fertility control measures would be necessary until horse numbers approach the high end of AML. In fact, with the use of fertility control and the potential for the Big Summit Territory herd to self-limit, the need for capture and removal of excess horses could be very minimal potentially generating very few to no effects associated with the gather and removal of horses from the Territory.

Under Alternative 3, fertility control measures would be implemented when the herds reach the low end of the AML range. Implementation of fertility control measures would slow down the population growth and reduce the need to initiate removals. Fertility control measures would be conducted in accordance with the SOPs described in Appendix 4. All fertility control methods recommended by the Wild Horse and Burro Advisory Board and approved for equine use by the EPA, FDA, or other governmental regulatory authority will be considered for use including contraception tools and sterilization tools as well as manipulation of sex ratios. The effects of the fertility control measures to horses are the same as described in Alternative 2.

See the previous discussion of effects common to all alternatives for effects directly related to wild horses with capture and removal, off-range and the Emergency Action Framework.

Cumulative Effects

See the previous discussion of cumulative effects common to all alternatives.

The focus of this cumulative effects discussion is on winter range forage utilization and competition for that forage. Wild horses, permitted livestock and wildlife species all compete for available forage within the Territory. Permitted livestock grazing overlaps in the Big Summit Territory. From mid-June to the end of September there are two bands of sheep permitted to graze on allotments that overlap with the Big Summit Territory. Forage competition for upland and riparian forage occurs between sheep and horses although dietary overlap between the two species in the summer time is small, sheep prefer forbs while horses prefer grasses. One study looked at the dietary overlap of pronghorn sheep and horses and found a summer overlap of only 7% (McInnis and Vavra, 1987) while another found a 21% dietary overlap in the summertime between wild horses and domestic sheep (Olsen and Hansen, 1977). Specifically, one band of sheep spends approximately 19 days in June grazing in the wild horse winter range. Permitted sheep use was voluntarily decreased because of a lack of forage (see Range Resource Report) from 2017-2019.

In addition to permitted livestock, wildlife species, specifically elk and deer compete with wild horses for forage in the Territory. Dietary overlap is greatest between elk and horses (Hosten, 2007) (Salter and Hudson, 1980). The current population levels for both elk and deer, while still below the Management Objectives, are higher than when the 1975 plan was developed. The Act limits agency authority to manage for horses where they occurred at the time of enactment. Therefore, the Territory must supply the complete forage needs for the horses year-round while elk and deer are free to roam to adjacent lands (see Wildlife Resource Report).

In Alternative 3, the AML would be set at 150-200 horses. Riparian utilization levels at this herd size, when combined with the use of permitted livestock and wildlife, is expected to range from 70-over 80%, and is expected to repeatedly exceed the Forest Plan allowable use standard and guideline of a maximum of 30% utilization (USDA, 1989). While permitted livestock numbers have stayed the same since 1975, wildlife species populations have increased since 1975, this will continue to affect forage utilization levels and potentially range conditions, especially in riparian areas. Repeated regular exceedance of the Forest Plan riparian allowable use standard and guideline is expected to prevent arresting downward trends and recovery of unsatisfactory riparian community conditions. In addition, lack of available forage in preferred habitats and limited space for harem occupancy is expected to result in increased horse movement outside of the Territory boundaries into adjacent National Forest System lands and onto adjacent private lands. As utilization of forage in the wild horse winter range increases prior to the onset of winter conditions or there is an above average snowfall winter, horses will have an increasingly harder time maintaining desirable body condition levels (above Henneke Body Score 2). Poorer body conditions through the winter are expected to result in reproductive and general health issues including miscarriages and increased contraction of diseases.

Forage utilization may also have a cumulative impact on upland/riparian resource conditions. While the Forest Plan allowable use standard and guideline for riparian communities in unsatisfactory condition is up to 30% of combined permitted livestock, wildlife and wild horse use in the Territory, there is more forage available so exceedance of this standard and guideline is expected to occur since riparian areas are preferred habitat for horses and we have minimum feasible management practices (WFRHBA) so herding or other management practices to move horses out of riparian areas will not occur. Therefore, repeated utilization exceedance over time increases the likelihood or probability of decline of the competitive advantage of species sensitive to grazing which in turn can result in species composition shift and ultimately riparian condition remaining in unsatisfactory condition and degrading.

In summary, the focus of the cumulative effects analysis for Alternative 3 is on competition between wild horses, permitted livestock and wildlife for winter range forage and the resultant expected levels of utilization. At the proposed AML of 150-200, repeated regular exceedance of the Forest Plan allowable use standard and guideline is expected across most riparian areas in the wild horse winter range regardless of winter snowfall amounts. This is expected to prevent recovery of riparian communities in unsatisfactory condition. However, vegetation management projects will temporarily improve upland forage conditions but not remove the exceedance of allowable use from riparian areas since they are the preferred areas. Competition for forage on the wild horse winter range has increased since 1975, especially between wild horses and wildlife.

Summary of Effects

In summary, all of the Alternatives is expected to require at some level of capture and removal of horses although that level is expected to vary between Alternatives with Alternatives 1 & 2 expected to require the largest number of captured and removed horses and Alternative 3 requiring the least. The action of capture and removal is expected to have similar potential effects on each horse captured (and on the remaining horses on the territory), however, the number of horses affected and frequency that these capture and removals effect horses remaining on the territory would be expected to vary between alternatives. These effects are discussed at the beginning of the effects section.

The largest variation between Alternatives lies in three action items: AML determination, Genetic Health management actions and Population Growth Control measures. Under Alternative 1 bringing herd size to within the AML range of 55-65 is expected to meet the Forest Plan riparian allowable use standard and guideline on most riparian communities, most years, with the exception of winters with above average snowfall. With a herd size within the range of AML under Alternative 2 it is expected that the Forest Plan riparian allowable use standard and guideline would be met on most riparian areas on all but the most extreme snow depth winters, with little to no repeated exceedance. Under Alternative 3 there is no expectation that the Forest Plan riparian allowable use standard and guideline would ever be met on most of the riparian areas in the wild horse winter range. For riparian community conditions, both Alternatives 1 & 2 will improve riparian communities with forage utilization levels meeting Forest Plan standards most if not all of the time across the Territory. Alternative 3 will not improve riparian community conditions and it is expected that most if not all of the riparian communities in the Territory will exceed Forest Plan standards. Alternative 2 is the only Alternative that is expected to improve the genetic variation of the herd, this Alternative allows the use of translocation as a tool to increase observed heterozygosity of the herd. Finally, population growth control measures and their associated effects vary by Alternative. Alternative 1 would only control population growth through capture and removal of excess horses. This represents the highest intensity of management and horse risk exposure of the alternatives analyzed. Alternative 2 would include both capture and removal of excess horses and the application of fertility control measures to address population growth. This Alternative could rely on both in the beginning to get down to the AML, increasing the exposure to risks for horses during capture, but would allow for minimum feasible management once the AML is achieved. Lastly, Alternative 3 would utilize tools of capture and removal and fertility control for population growth management; however, because the AML is so high in this Alternative, the need to capture horses may be less than any other Alternative, but the adverse effects to riparian community condition and horse body condition associated with allowing the horse herd to approach a self-limiting status are expected to fail to comply with the thriving natural ecological balance mandate of the Act. See Table 20 for a comparison of the projected utilization levels in riparian communities.

Table 20: Comparison of Projected Utilization to Forest Plan Riparian Allowable Use Standard and Guideline by Alternative at High AML

Forest Plan Riparian Allowable Use Standard and Guideline	Alternative 1	Alternative 2	Alternative 3
0-30%	32-46%	0-30%	73-86%

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Appendices

APPENDIX 1: EMERGENCY ACTION FRAMEWORK

The Emergency Action Framework is a guide to help decision makers in the event of an emergency situation in which a wild horse may be suffering. Any emergency involving a wild horse will be looked at on a case-by-case basis with regards to the humane treatment of the horse, the long-term well-being of the wild horse herd and maintaining the “wildness” of the herd as priority. The Emergency Action Framework will focus on euthanasia of wild horses for reasons related to health, handling and act of mercy.

Final decisions regarding euthanasia of a wild horse rest solely with the authorize officer (36 CFR 222.60 Subpart D). It is understood that there will be cases where this decision must be made in the field and cannot always be anticipated. Appropriate wild horse personnel at facilities and in the field should be consulted for information needed to make a decision. A task force may be assembled for the emergency if the authorizing officer deems necessary and/or consultation with a veterinarian may be sought. Euthanasia as an act of mercy will be carried out following the direction in FSM 2260. The death record should specify that euthanasia was performed and the reason that it was performed.

A Forest Service authorized officer shall use these definitions for guidance:

1. Sick- a wild horse with failing health, infirmness, or disease from which there is little chance of recovery or poor prognosis.
2. Lame-a wild horse with malfunctioning muscles, ligaments or limbs that impair freedom of movement.
3. Old-a wild horse characterized by inability to fend for itself because of age, physical deterioration, suffering or closeness to death.

A Forest Service Authorized officer will euthanize or authorize euthanasia of a wild horse when any of the following conditions exist:

1. Displays a poor prognosis for life;
2. Falls under the definitions of sick, lame or old;
3. Would require continuous treatment for the relief of pain and suffering in a domestic setting;
4. Is incapable of maintaining a Henneke body condition score (see Attachment 1) greater than or equal to a 2 in its present environment;
5. Has an acute or chronic illness, injury-, physical condition or lameness that would not allow the animal to live and interact with other horses, keep up with its peers or maintain an acceptable quality of life constantly or for the foreseeable future;
6. Where a State or Federal animal health official orders the humane destruction of the animal(s) as a disease control measure;
7. Exhibits dangerous characteristics beyond those inherently associated with the wild characteristics of wild horses or is a public safety threat.

When euthanasia will be performed and how decisions will be made and recorded in a variety of circumstances is described below.

Euthanasia in field situations (includes on-the-range and during gathers):

1. If an animal is affected by a condition as described in 1-7 above that causes acute pain or suffering and immediate euthanasia would be an act of mercy, the authorized officer should promptly euthanize the animal.
2. The authorized officer will document any euthanasia under act of mercy.

Euthanasia at short-term holding facilities:

Ideally, no horse would arrive at short-term holding facilities with conditions that require euthanasia. However, problems can develop during or be exacerbated by handling, transportation or captivity. In these situations that authority for euthanasia should be applied as follows:

1. If an animal is affected by a condition as described in 1-7 above that causes acute pain or suffering and immediate euthanasia would be an act of mercy, the authorized officer should promptly euthanize the animal.
2. If an animal is affected by a condition as described in 1-7 above, but is not in acute pain, the authorized officer has the authority to euthanize the animal, but should first consult a veterinarian.
3. If the authorized officer concludes, after consulting with a veterinarian, that a wild horse in a short-term holding facility cannot tolerate the stress of transportation or adoption preparation then the animal should be euthanized.

Humane Destruction of unusually dangerous animals:

Unusually aggressive wild horses can pose an unacceptable risk of injury when maintained in enclosed spaces where some level of handling is required. When a horse is unusually dangerous, it is reasonable to conclude that an average adopter could not humanely care for the animals as required by regulations. When deciding to euthanize an animal because it is unusually dangerous, the authorized officer, in consultation with a veterinarian or task force, should determine that the animal poses a significant and unusual danger to people or other animals beyond that normally associated with wild horses. The authorized officer should document the aspects of the animal's behavior that make it unusually dangerous.

Euthanasia of a large number of animals for reasons related to health, handling and acts of mercy:

When the need for euthanasia of an unusually large number of animals is anticipated, the likely course of action should be identified and outlined in advance whenever possible. Arrangements should be made for a USDA Animal and Plant Health Inspection Service (APHIS), State or other veterinarian to visit the site and consult with the authorized officer on the euthanasia decisions. This consultation should be based on an examination of the animals by the veterinarian. It should include a detailed, written evaluation of the conditions, circumstances or history of the situation and the number of animals involved.

APPENDIX 2: COMPREHENSIVE ANIMAL WELFARE PROGRAM FOR WILD HORSE AND BURRO GATHERS STANDARDS

WELFARE ASSESSMENT STANDARDS for GATHERS
CONTENTS

I. FACILITY DESIGN

A. Trap Site and Temporary Holding Facility

1. The trap site and temporary holding facility must be constructed of stout materials and must be maintained in proper working condition, including gates that swing freely and latch or tie easily.

2. The trap site should be moved close to WH&B locations whenever possible to minimize the distance the animals need to travel.

3. Fence panels in pens and alleys must be not less than 6 feet high for horses, 5 feet high for burros, and the bottom rail must not be more than 12 inches from ground level.

4. There must be no holes, gaps or openings, protruding surfaces, or sharp edges present in fence panels or other structures that may cause escape or possible injury.

5. Hinged, self-latching gates must be used in all pens and alleys except for entry gates into the trap, which may be secured with tie ropes.

7. Finger gates (one-way funnel gates) used in bait trapping must not be constructed of materials that have sharp ends that may cause injuries to WH&Bs, such as "T" posts, sharpened willows, etc.

8. The design of pens at the trap site should be constructed with rounded corners where possible.

9. Non-essential personnel and equipment must be located to minimize disturbance of WH&Bs.

10. Trash, debris, and reflective or noisy objects should be eliminated from the trap site.

B. Loading and Unloading Areas

1. Facilities in areas for loading and unloading WH&Bs at the trap site must be maintained in a safe and proper working condition, including gates that swing freely and latch or tie easily.

2. There must be no holes, gaps or openings, protruding surfaces, or sharp edges present in fence panels or other structures that may cause escape or possible injury.

3. All gates and doors must open and close easily and latch securely.

4. Trailers must be properly aligned with loading and unloading chutes and panels such that minimum size gaps exist between the chute/panel and floor or sides of the trailer not creating a situation where a WH&B could injure itself.

5. Stock trailers should be positioned for loading or unloading such that there is no more than 18” clearance between the ground and floor of the trailer for horses.

II. CAPTURE TECHNIQUE

A. Capture Techniques

1. WH&Bs gathered on a routine basis for removal or return to range must be captured by the following approved procedures under direction of the Forest.

   a. Helicopter

   b. Bait trapping

2. WH&Bs must not be captured by snares or net gunning.

3. Chemical immobilization must only be used for capture under exceptional circumstances and under the direct supervision of an on-site veterinarian experienced with the technique.

B. Helicopter Drive Trapping

1. The helicopter must be operated using pressure and release methods to herd the animals in a desired direction and should not repeatedly evoke erratic behavior in the WH&Bs causing injury or exhaustion. Animals must not be pursued to a point of exhaustion; the on-site veterinarian must examine WH&Bs for signs of exhaustion.

2. The rate of movement and distance the animals travel must not exceed limitations set by Forest staff who will consider terrain, physical barriers, access limitations, weather, condition of the animals, urgency of the operation (animals facing drought, starvation, fire, etc.) and other factors.

   a. WH&Bs that are weak or debilitated must be identified by Forest staff or the contractors. Appropriate gather and handling methods should be used according to the direction of the Forest staff.

   b. The appropriate herding distance and rate of movement must be determined on a case-by-case basis considering the weakest or smallest animal in the group (e.g., foals, pregnant mares, or horses that are weakened by body condition, age, or poor health) and the range and environmental conditions present.

   c. Rate of movement and distance travelled must not result in exhaustion at the trap site, with the exception of animals requiring capture that have an existing severely compromised condition prior to gather. Where compromised animals cannot be left on the range or where doing so would only serve to prolong their suffering, euthanasia will be performed in accordance with Forest Service policy.

3. WH&Bs must not be pursued repeatedly by the helicopter such that the rate of movement and distance travelled exceeds the limitation set by the Forest. Abandoning the pursuit or alternative capture methods may be considered by the Forest in these cases.

4. When WH&Bs are herded through a fence line en route to the trap, the Forest must be notified by the contractor. The Forest must determine the appropriate width of the opening that the fence is let down to allow for safe passage through the opening. The Forest must decide if existing fence lines require marking to increase visibility to WH&Bs.

5. The helicopter must not come into physical contact with any WH&B. The physical contact of any WH&B by helicopter must be documented by the Forest along with the circumstances.

6. WH&Bs may escape or evade the gather site while being moved by the helicopter. If there are mare/dependent foal pairs in a group being brought to a trap and half of an identified pair is thought to have evaded capture, multiple attempts by helicopter may be used to bring the missing half of the pair to the trap or to facilitate capture by roping. In these instances, animal condition and fatigue must be

evaluated by the Forest staff or on-site veterinarian on a case-by-case basis to determine the number of attempts that can be made to capture an animal.

7. Horse captures must not be conducted when ambient temperature at the trap site is below 10ºF or above 95ºF without approval of the Forest.

C. Roping

1. The roping of any WH&B must be approved prior to the procedure by the Forest staff.

2. The roping of any WH&B must be documented by the Forest along with the circumstances. WH&Bs may be roped under circumstances which include but are not limited to the following: reunite a mare or jenny and her dependent foal; capture nuisance, injured or sick WH&Bs or those that require euthanasia; environmental reasons such as deep snow or traps that cannot be set up due to location or environmentally sensitive designation; and public and animal safety or legal mandates for removal.

3. Ropers should dally the rope to their saddle horn such that animals can be brought to a stop as slowly as possible and must not tie the rope hard and fast to the saddle so as to intentionally jerk animals off their feet.

4. WH&Bs that are roped and tied down in recumbency must be continuously observed and monitored by an attendant at a maximum of 100 feet from the animal.

5. WH&Bs that are roped and tied down in recumbency must be untied within 30 minutes.

6. If the animal is tied down within the wings of the trap, helicopter drive trapping within the wings will cease until the tied-down animal is removed.

7. Sleds, slide boards, or slip sheets must be placed underneath the animal's body to move and/or load recumbent WH&Bs.

8. Halters and ropes tied to a WH&B may be used to roll, turn, position or load a recumbent animal, but a WH&B must not be dragged across the ground by a halter or rope attached to its body while in a recumbent position.

D. Bait Trapping

1. WH&Bs may be lured into a temporary trap using bait (feed, mineral supplement, water) or sexual attractants (mares/jennies in heat) with the following requirements:

a. The period of time water sources other than in the trap site are inaccessible must not adversely affect the wellbeing of WH&Bs, wildlife or livestock, as determined by the Forest staff.

b. Unattended traps must not be left unobserved for more than 24 hours.

c. Mares/jennies and their dependent foals must not be separated unless for safe transport.

d. WH&Bs held for more than 24 hours during winter conditions and 12 hours during summer conditions must be provided with accessible clean water at a minimum rate of twenty gallons per 1000 pound animal per day, adjusted accordingly for larger or smaller horses, burros and foals and environmental conditions.

e. WH&Bs held for more than 24 hours must be provided good quality hay at a minimum rate of 20 pounds per 1000 pound adult animal per day, adjusted accordingly for larger or smaller horses, burros and foals.

1) Hay must not contain poisonous weeds, debris, or toxic substances.

2) Hay placement must allow all WH&Bs to eat simultaneously.

III. WILD HORSE AND BURRO CARE

A. Veterinarian

1. On-site veterinary support must be provided for all helicopter gathers and on-site or on-call support must be provided for bait trapping.

2. Veterinary support must be under the direction of the Forest staff. The on-site/on-call veterinarian will provide consultation on matters related to WH&B health, handling, welfare, and euthanasia at the request of the Forest. All decisions regarding medical treatment or euthanasia will be made by the Forest.

B. Care

1. Feeding and Watering

a. Adult WH&Bs held in traps or temporary holding pens for longer than 24 hours must be fed daily with water available at all times other than when animals are being sorted or worked.

b. Water must be provided at a minimum rate of twenty gallons per 1000 pound animal per day, adjusted accordingly for larger or smaller horses, burros and foals, and environmental conditions.

c. Good quality hay must be fed at a minimum rate of 20 pounds per 1000 pound adult animal per day, adjusted accordingly for larger or smaller horses, burros and foals.

i. Hay must not contain poisonous weeds or toxic substances.

ii. Hay placement must allow all WH&Bs to eat simultaneously.

d. When water or feed deprivation conditions exist on the range prior to the gather, the Forest should adjust the watering and feeding arrangements in consultation with the on-call veterinarian as necessary to provide for the needs of the animals.

2. Dust abatement

a. Dust abatement by spraying the ground with water must be employed when necessary at the trap site and temporary holding facility.

3. Trap Site

a. Dependent foals (less than 300lbs) or weak/debilitated animals must be separated from other WH&Bs at the trap site to avoid injuries during transportation to the temporary holding facility. Separation of dependent foals from mares must not exceed four hours unless the Forest authorizes a longer time or a decision is made to wean the foals.

4. Temporary Holding Facility

a. All WH&Bs in confinement must be observed at least once daily to identify sick or injured WH&Bs and ensure adequate food and water.

b. Foals must be reunited with their mares/jennies at the temporary holding facility within four hours of capture unless the Forest authorizes a longer time or foals are old enough to be weaned during the gather.

c. Non-ambulatory WH&Bs must be located in a pen separate from the general population and must be examined by the BLM horse specialist and/or on-call or on-site veterinarian as soon as possible, no more than four hours after recumbency is observed. Unless otherwise directed by a veterinarian, hay and water must be accessible to an animal within six hours after recumbency.

d. Alternate pens must be made available for the following:

1) WH&Bs that are weak or debilitated

2) Mares/jennies with dependent foals

e. Aggressive WH&Bs causing serious injury to other animals should be identified and relocated into alternate pens when possible.

f. WH&Bs in pens at the temporary holding facility should be maintained at a proper stocking density such that when at rest all WH&Bs occupy no more than half the pen area.

IV. HANDLING

A. Willful Acts of Abuse

1. Hitting, kicking, striking, or beating any WH&B in an abusive manner is prohibited.

2. Dragging a recumbent WH&B without a sled, slide board or slip sheet is prohibited.

3. There should be no deliberate driving of WH&Bs into other animals, closed gates, panels, or other equipment.

4. There should be no deliberate slamming of gates and doors on WH&Bs.

5.There should be no excessive noise (e.g., constant yelling) or sudden activity causing WH&Bs to become unnecessarily flighty, disturbed or agitated.

B. General Handling

1. All sorting, loading or unloading of WH&Bs during gathers must be performed during daylight hours except when unforeseen circumstances develop and the Forest approves the use of supplemental light.

2.WH&Bs should be handled to enter runways or chutes in a forward direction.

3.WH&Bs should not remain in single-file alleyways, runways, or chutes longer than 30 minutes.

4. Equipment except for helicopters should be operated and located in a manner to minimize flighty behavior.

C. Handling Aids

1. Handling aids such as sorting sticks, flags and shaker paddles must be the primary tools for driving and moving WH&Bs during handling and transport procedures. Contact of the flag or paddle end of primary handling aids with a WH&B is allowed. Ropes looped around the hindquarters may be used from horseback or on foot to assist in moving an animal forward or during loading.

2. Electric prods must not be used routinely as a driving aid or handling tool. Electric prods may be used in limited circumstances only if the following guidelines are followed:

a. Electric prods must only be a commercially available make and model that uses DC battery power and batteries should be fully charged at all times.

b. The electric prod device must never be disguised or concealed.

c. Electric prods must only be used after three attempts using other handling aids (flag, shaker paddle, voice or body position) have been tried unsuccessfully to move the WH&Bs.

d. Electric prods must only be picked up when intended to deliver a stimulus; these devices must not be constantly carried by the handlers.

e. Space in front of an animal must be available to move the WH&B forward prior to application of the electric prod.

f. Electric prods must never be applied to the face, genitals, anus, or underside of the tail of a WH&B.

g. Electric prods must not be applied to any one WH&B more than three times during a procedure (e.g., sorting, loading) except in extreme cases with approval of the Forest.

h. Any electric prod use that may be necessary must be documented daily by Forest staff including time of day, circumstances, handler, location (trap site or temporary holding facility), and any injuries (to WH&B or human).

V. TRANSPORTATION

A. General

1. All sorting, loading, or unloading of WH&Bs during gathers must be performed during daylight hours except when unforeseen circumstances develop and the Forest approves the use of supplemental light.

2. Wild horses identified for removal should be shipped from the temporary holding facility to a short-term facility within 48 hours.

a. Shipping delays for animals that are being held for release to range or potential on-site adoption must be approved by Forest staff.

3. Shipping should occur in the following order of priority; 1) debilitated animals, 2) pairs, 3) weanlings, 4) dry mares and 5) studs.

4. Planned transport time to the temporary short-term holding facility from the trap site or temporary holding facility must not exceed 10 hours.

5. WH&Bs should not wait in stock trailers and/or semi-trailers at a standstill for more than a combined period of three hours during the entire journey.

B. Vehicles

1. Straight-deck trailers and stock trailers must be used for transporting WH&Bs.

a. Two-tiered or double deck trailers are prohibited.

b. Transport vehicles for WH&Bs must have a covered roof or overhead bars containing them such that WH&Bs cannot escape.

2. WH&Bs must have adequate headroom during loading and unloading and must be able to maintain a normal posture with all four feet on the floor during transport without contacting the roof or overhead bars.

3. The width and height of all gates and doors must allow WH&Bs to move through freely.

4. All gates and doors must open and close easily and be able to be secured in a closed position.

5. The rear door(s) of the trailers must be capable of opening the full width of the trailer.

6. Loading and unloading ramps must have a non-slip surface and be maintained in proper working condition to prevent slips and falls.

7. Transport vehicles more than 18 feet and less than 40 feet in length must have a minimum of one partition gate providing two compartments; transport vehicles 40 feet or longer must have at least two partition gates to provide a minimum of three compartments.

8. All partitions and panels inside of trailers must be free of sharp edges or holes that could cause injury to WH&Bs.

9. The inner lining of all trailers must be strong enough to withstand failure by kicking that would lead to injuries.

10. Partition gates in transport vehicles should be used to distribute the load into compartments during travel.

11. Surfaces and floors of trailers must be cleaned of dirt, manure and other organic matter prior to the beginning of a gather.

C. Care of WH&Bs during Transport Procedures

1. WH&Bs that are loaded and transported must be fit to endure travel.

    a. WH&Bs that are non-ambulatory, blind in both eyes, or severely injured must not be loaded and shipped unless it is to receive immediate veterinary care or euthanasia.

    b. WH&Bs that are weak or debilitated must not be transported without approval of the Forest in consultation with the on-call veterinarian. Appropriate actions for their care during transport must be taken according to direction of the Forest.

2. WH&Bs should be sorted prior to transport to ensure compatibility and minimize aggressive behavior that may cause injury.

3. Trailers must be loaded using the minimum space allowance in all compartments as follows:

    a. 12 square feet per adult horse.

    b. 6.0 square feet per dependent horse foal.

    c. 8.0 square feet per adult burro.

    d. 4.0 square feet per dependent burro foal.

4. Saddle horses must not be transported in the same compartment with WH&Bs.

VI. EUTHANASIA OR DEATH

A. Euthanasia Procedure during Gather Operations

1. An authorized, properly trained, and experienced person as well as a firearm appropriate for the circumstances must be available at all times during gather operations. When the travel time between the trap site and temporary holding facility exceeds one hour or if radio or cellular communication is not reliable, provisions for euthanasia must be in place during the gather operation.

2. Euthanasia must be performed according to American Veterinary Medical Association euthanasia guidelines (2013) using methods of gunshot or injection of an approved euthanasia agent.

3. The decision to euthanize and method of euthanasia must be directed by the Authorized Officer or their Authorized Representative(s) that include but are not limited to Forest staff who must be on site and may consult with the on-site/on-call veterinarian.

4. Photos needed to document an animal's condition should be taken prior to the animal being euthanized.

5. Any WH&B that dies or is euthanized must be documented by Forest staff including time of day, circumstances, euthanasia method, location, a description of the age, gender, and color of the animal and the reason the animal was euthanized.

B. Carcass Disposal

1. The Forest must ensure that appropriate equipment is available for the timely disposal of carcasses when necessary.

2. Disposal of carcasses must be in accordance with state and local laws.

3. WH&Bs euthanized with a barbiturate euthanasia agent must be buried or otherwise disposed of properly.

4. Carcasses left on the range should not be placed in washes or riparian areas where future runoff may carry debris into ponds or waterways. Trenches or holes for buried animals should be dug so the bottom of the hole is at least 6 feet above the water table and 4-6 feet of level earth covers the top of the carcass with additional dirt mounded on top where possible.

APPENDIX 3: BLM FERTILITY CONTROL LITERATURE REVIEW AND EFFECTS DISCUSSION

PZP

BLMs Use of Contraception in Wild Horse Management

Expanding the use of population growth suppression to slow population growth rates and reduce the number of animals removed from the range and sent to off-range pastures (ORPs) is a BLM priority. The WFRHBA of 1971 specifically provides for contraception and sterilization (section 3.b.1). No finding of excess animals is required for BLM to pursue contraception in wild horses or wild burros. Contraception has been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used with other techniques, to reduce horse population size (Bartholow 2004, de Seve and Boyles-Griffin 2013). All fertility control methods in wild animals are associated with potential risks and benefits, including effects of handling, frequency of handling, physiological effects, behavioral effects, and reduced population growth rates (Hampton et al. 2015). Contraception by itself does not remove excess horses from an HMA's population, so if a wild horse population is in excess of AML, then contraception alone would result in some continuing environmental effects of horse overpopulation. Successful contraception reduces future reproduction. Limiting future population increases of horses could limit increases in environmental damage from higher densities of horses than currently exist. Horses are long-lived, potentially reaching 20 years of age or more in the wild and, if the population is above AML, treated horses returned to the HMA may continue exerting negative environmental effects, as described in the effects section throughout their life span. In contrast, if horses above AML are removed when horses are gathered, that leads to an immediate decrease in the severity of ongoing detrimental environmental effects.

Successful contraception would be expected to reduce the frequency of horse gather activities on the environment, as well as wild horse management costs to taxpayers. Bartholow (2007) concluded that the application of 2 or 3-year contraceptives to wild mares could reduce operational costs in a project area by 12-20%, or up to 30% in carefully planned population management programs. He also concluded that contraceptive treatment would likely reduce the number of horses that must be removed in total, with associated cost reductions in the number of adoptions and total holding costs. If applying contraception to horses requires capturing and handling horses, the risks and costs associated with capture and handling of horses may be comparable to those of gathering for removal, but with expectedly lower adoption and long-term holding costs. Population suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000). Selectively applying contraception to older animals and returning them to the HMA could reduce long-term holding costs for such horses, which are difficult to adopt, and could reduce the compensatory reproduction that often follows removals (Kirkpatrick and Turner 1991). On the other hand, selectively applying contraception to younger animals can slow the rate of genetic diversity loss – a process that tends to be slow in a long-lived animal with high levels of genetic diversity – and could reduce growth rates further by delaying the age of first parturition (Gross 2000). Although contraceptive treatments may be associated with a number of potential physiological, behavioral, demographic, and genetic effects, detailed below, those concerns do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013).

The literature review is intended to summarize what is known and what is not known about potential effects of treating mares with porcine zona pellucida (PZP) vaccine. As noted below, some negative consequences of vaccination are possible. PZP vaccines are administered only to females.

Whether to use or not use this method to reduce population growth rates in wild horses is a decision that must be made considering those effects as well as the potential effects of inaction, such as continued overpopulation and rangeland health degradation.

Reference in this text to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement, recommendation, or favoring by the Department of the Interior.

Porcine Zona Pellucida (PZP) Vaccine

The immune-contraceptive Porcine Zona Pellucida (PZP) vaccine is currently being used on over 75 areas managed for wild horses by the National Park Service, US Forest Service, and the Bureau of Land Management and its use is appropriate for free-ranging wild horse herds. Taking into consideration available literature on the subject, the National Research Council concluded in their 2013 report that PZP was one of the preferable available methods for contraception in wild horses and burros (NRC 2013). PZP use can reduce or eliminate the need for gathers and removals (Turner et al. 1997). PZP vaccines meet most of the criteria that the National Research Council (2013) used to identify promising fertility control methods, in terms of delivery method, availability, efficacy, and side effects. It has been used extensively in wild horses (NRC 2013), and in a population of feral burros in territory of the US (Turner et al. 1996). PZP is relatively inexpensive, meets BLM requirements for safety to mares and the environment, and is commercially produced as ZonaStat-H, an EPA-registered product (EPA 2012, SCC 2015), or as PZP-22, which is a formulation of PZP in polymer pellets that can lead to a longer immune response (Turner et al. 2002, Rutberg et al. 2017). It can easily be remotely administered in the field in cases where mares are relatively approachable.

Under the Proposed Action, the BLM would return to the HMA as needed to re-apply PZP-22 and / or ZonaStat-H and initiate new treatments in order to maintain contraceptive effectiveness in controlling population growth rates. Both forms of PZP can safely be reapplied as necessary to control the population growth rate. Even with repeated booster treatments of PZP, it is expected that most, if not all, mares would return to fertility. Once the population is at AML and population growth seems to be stabilized, BLM could use population planning software (WinEquus II, currently in development by USGS Fort Collins Science Center) to determine the required frequency of re-treating mares with PZP.

PZP Direct Effects

When injected as an antigen in vaccines, PZP causes the mare's immune system to produce antibodies that are specific to zona pellucida proteins on the surface of that mare's eggs. The antibodies bind to the mare's eggs surface proteins (Liu et al. 1989), and effectively block sperm binding and fertilization (Zoo Montana, 2000). Because treated mares do not become pregnant but other ovarian functions remain generally unchanged, PZP can cause a mare to continue having regular estrus cycles throughout the breeding season. Research has demonstrated that contraceptive efficacy of an injected PZP vaccine is approximately 90% for mares treated twice in the first year and boostered annually (Kirkpatrick et al., 1992). Approximately 60% to 85% of mares are successfully contracepted for one year when treated simultaneously with a liquid primer and PZP-22 pellets (Rutberg et al. 2017). In addition, among mares, PZP contraception appears to be reversible, with most treated mares returning to fertility over time. PZP vaccine application at the capture site does not appear to affect normal development of the fetus or foal, hormone health of the mare or behavioral responses to stallions, should the mare already be pregnant when vaccinated (Kirkpatrick et al. 2002). The vaccine has no apparent effect on pregnancies in progress or the health of offspring (Kirkpatrick and Turner 2003).

The NRC (2013) criterion by which PZP is not a good choice for wild horse contraception was duration. The ZonaStat-H formulation of the vaccine tends to confer only one year of efficacy. Some studies have found that a PZP vaccine in long-lasting pellets (PZP-22) can confer multiple years of contraception (Turner et al. 2007), particularly when boostered with subsequent PZP vaccination (Rutberg et al. 2017). Other trial data, though, indicate that the pelleted vaccine may only be effective for one year (J. Turner, University of Toledo, Personal Communication).

Following a gather, application of PZP for fertility control would reduce fertility in a large percentage of mares for at least one year (Ransom et al. 2011). Recruitment of foals into the population may be reduced over a three- year period. Gather efficiency would likely not exceed 85% via helicopter, and may be less with bait and water trapping, so there would be a portion of the female population uncaptured that is not treated in any given year. Additionally, some mares may not respond to the fertility control vaccine, but instead will continue to foal normally.

In most cases, PZP contraception appears to be temporary and reversible (Kirkpatrick and Turner 2002, Joonè et al. 2017), does not appear to cause out-of-season births (Kirkpatrick and Turner 2003), and has no ill effects on ovarian function if contraception is not repeated for more than five consecutive years on a given mare. Although the rate of long-term or permanent sterility following repeated vaccinations with PZP has not been quantified, it must be acknowledged that this could be a result for some number of wild horses receiving multiple repeat PZP vaccinations. Even though it is not the intent of PZP treatment, the permanent sterility of a fraction of treated mares is a potential result that would be consistent with the contraceptive purpose of applying the vaccine to wild mares.

Although most treatments with PZP will be reversible, repeated treatment with PZP may lead to long-term infertility (Feh 2012) and, perhaps, direct effects on ovaries (Gray and Cameron 2010). Bechert et al. (2013) found that ovarian function was affected by the SpayVac PZP vaccination, but that there were no effects on other organ systems. Mask et al. (2015) demonstrated that equine antibodies that resulted from SpayVac immunization could bind to oocytes, ZP proteins, follicular tissues, and ovarian tissues, but it is possible that result is specific to SpayVac, which may have lower PZP purity than ZonaStat or PZP-22 (Hall et al. 2016). Joonè et al. (2017) found effects on ovaries after SpayVac PZP vaccination in some treated mares, but normal estrus cycling had resumed 10 months after the last treatment. SpayVac is a patented formulation of PZP in liposomes that can lead to multiple years of infertility (Roelle et al. 2017) but which is not reliably available for BLM to use at this time. Kirkpatrick et al. (1992) noted effects on ovaries after three years of treatment with PZP. Observations at Assateague Island National Seashore indicate that the more times a mare is consecutively treated, the longer the time lag before fertility returns, but that even mares treated 7 consecutive years did return to ovulation (Kirkpatrick and Turner 2002). Other studies have reported that continued applications of PZP may result in decreased estrogen levels (Kirkpatrick et al., 1992) but that decrease was not biologically significant, as ovulation remained similar between treated and untreated mares (Powell and Monfort 2001). Permanent sterility for mares treated consecutively 5-7 years was observed by Nunez et al. (2010, 2017). In a graduate thesis, Knight (2014) suggested that repeated treatment with as few as three to four years of PZP treatment may lead to longer-term sterility, and that sterility may result from PZP treatment before puberty.

If a mare is already pregnant, the PZP vaccine has not been shown to affect normal development of the fetus or foal, or the hormonal health of the mare with relation to pregnancy. In mice, Sacco et al. (1981) found that antibodies specific to PZP can pass from mother mouse to pup via the placenta or colostrum, but that did not apparently cause any innate immune response in the offspring: the level of those antibodies were undetectable by 116 days after birth. There was no indication in that study that the fertility or ovarian function of those pups was compromised, nor is BLM aware of any such results in horses or burros.

On-range observations from 20 years of application to wild horses indicate that PZP application in wild mares does not generally cause mares to foal out of season or late in the year (Kirkpatrick and Turner 2003). Nunez's (2010) research showed that a small number of mares that had been previously been treated with PZP foaled later than untreated mares and expressed the concern that this late foaling "may" impact foal survivorship and decrease band stability, or that higher levels of attention from stallions on PZP-treated mares might harm those mares. However, that paper provided no evidence that such impacts on foal survival or mare well-being actually occurred. Rubenstein (1981) called attention to a number of unique ecological features of horse herds on Atlantic barrier islands, which calls into question whether inferences drawn from island herds can be applied to western wild horse herds. Ransom et al. (2013), though, identified a potential shift in reproductive timing as a possible drawback to prolonged treatment with PZP, stating that treated mares foaled on average 31 days later than non-treated mares. Those results, however, showed that over 81% of the documented births in this study were between March 1 and June 21, i.e., within the normal spring season. Ransom et al. (2013) advised that managers should consider carefully before using PZP in small refugia or rare species. Wild horses and burros in Nevada do not generally occur in isolated refugia, and they are not a rare species. Moreover, an effect of shifting birth phenology was not observed uniformly: in two of three PZP-treated wild horse populations studied by Ransom et al. (2013), foaling season of treated mares extended three weeks and 3.5 months, respectively, beyond that of untreated mares. In the other population, the treated mares foaled within the same time period as the untreated mares. Moreover, Ransom et al. (2013) found no negative impacts on foal survival even with an extended birthing season.

Mares receiving the vaccine would experience slightly increased stress levels associated with handling while being vaccinated and freeze-marked. Newly captured mares that do not have markings associated with previous fertility control treatments would be marked with a new freeze-mark for the purpose of identifying that mare, and identifying her PZP vaccine treatment history. This information would also be used to determine the number of mares captured that were not previously treated, and could provide additional insight regarding gather efficiency.

Most mares recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from the fertility control injections, other than the direct consequence of becoming temporarily infertile. Injection site reactions associated with fertility control treatments are possible in treated mares (Roelle and Ransom 2009, Bechert et al. 2013), but swelling or local reactions at the injection site are expected to be minor in nature. Roelle and Ransom (2009) found that the most time-efficient method for applying PZP is by hand-delivered injection of 2-year pellets when horses are gathered. They observed only two instances of swelling from that technique. Use of remotely delivered, 1-year PZP is generally limited to populations where individual animals can be accurately identified and repeatedly approached. The dart-delivered formulation produced injection-site reactions of varying intensity, though none of the observed reactions appeared debilitating to the animals (Roelle and Ransom 2009). Joonè et al. (2017) found that injection site reactions had healed in most mares within 3 months after the booster dose, and that they did not affect movement or cause fever. The longer term nodules observed did not appear to change any animal's range of movement or locomotor patterns and in most cases did not appear to differ in magnitude from naturally occurring injuries or scars.

Indirect Effects
One expected long-term, indirect effect on wild horses treated with fertility control would be an improvement in their overall health. Many treated mares would not experience the biological stress of reproduction, foaling and lactation as frequently as untreated mares, and their better health is expected to be reflected in higher body condition scores (Nunez et al. 2010). After a treated mare returns to fertility, her future foals would be expected to be healthier overall, and would benefit from improved nutritional quality in the mares' milk. This is particularly to be expected if there is an improvement in rangeland forage quality at the same time, due to reduced wild horse population size. Past application of fertility control has shown that mares' overall health and body condition remains improved even after fertility resumes. PZP treatment may increase mare survival rates, leading to longer potential lifespan (Ransom et al. 2014a). To the extent that this happens, changes in lifespan and decreased foaling rates could combine to cause changes in overall age structure in a treated herd (i.e., Roelle et al. 2010). Observations of mares treated in past gathers showed that many of the treated mares were larger than, maintained higher body condition than, and had larger healthy foals than untreated mares. Following resumption of fertility, the proportion of mares that conceive and foal could be increased due to their increased fitness; this has been called a 'rebound effect.' More research is needed to document and quantify these hypothesized effects; however, it is believed that repeated contraceptive treatment may minimize this rebound effect.

Because successful fertility control would reduce foaling rates and population growth rates, another indirect effect would be to reduce the number of wild horses that have to be removed over time to achieve and maintain the established AML. So long as the level of contraceptive treatment is adequate, the lower expected birth rates can compensate for any expected increase in the survival rate of treated mares. Also, reducing the numbers of wild horses that would have to be removed in future gathers could allow for removal of younger, more easily adoptable excess wild horses, and thereby could eliminate the need to send additional excess horses from this area to long term pastures (LTPs). A high level of physical health and future reproductive success of fertile mares within the herd would be sustained, as reduced population sizes would be expected to lead to more availability of water and forage resources per capita.

Reduced population growth rates and smaller population sizes would also allow for continued and increased environmental improvements to range conditions within the project area, which would have long-term benefits to wild horse habitat quality. As the population nears or is maintained at the level necessary to achieve a thriving natural ecological balance, vegetation resources would be expected to recover, improving the forage available to wild horses and wildlife throughout HMA. With a more optimal distribution of wild horses across the HMA, at levels closer to a thriving ecological balance, there would also be less trailing and concentrated use of water sources, which would have many benefits to the wild horses still on the range. There would be reduced competition among wild horses using the water sources, and less fighting would occur among studs and individual animals to access water sources. Water quality and quantity would continue to improve to the benefit of all rangeland users including wild horses. Wild horses would also have to travel less distance back and forth between water and desirable foraging areas. Should PZP booster treatment and repeated fertility control treatment continue into the future, the chronic cycle of overpopulation and large gathers and removals would no longer occur, but instead a consistent cycle of balance and stability would ensue, resulting in continued improvement of overall habitat conditions and animal health.

Behavioral Effects

The NRC report (2013) noted that all fertility suppression has effects on mare behavior, mostly as a result of the lack of pregnancy and foaling, and concluded that PZP was a good choice for use in the program. The result that PZP-treated mares may continue estrus cycles throughout the breeding season can lead to behavioral differences, when compared to mares that are fertile. Such behavioral differences should be considered as potential consequences of successful contraception.

Ransom and Cade (2009) delineate behaviors that can be used to test for quantitative differences due to treatments. Ransom et al. (2010) found no differences in how PZP-treated and untreated mares allocated their time between feeding, resting, travel, maintenance, and most social behaviors in three populations of wild horses, which is consistent with Powell's (1999) findings in another population. Likewise, body condition of PZP-treated and control mares did not differ between treatment groups in Ransom et al.'s (2010) study. Nunez (2010) found that PZP-treated mares had higher body condition than control mares in another population, presumably because energy expenditure was reduced by the absence of pregnancy and lactation. Knight (2014) found that PZP-treated mares had better body condition, lived longer and switched harems more frequently, while mares that foaled spent more time concentrating on grazing and lactation and had lower overall body condition. Studies on Assateague Island (Kirkpatrick and Turner 2002) showed that once fillies (female foals) that were born to mares treated with PZP during pregnancy eventually breed, they produce healthy, viable foals.

In two studies involving a total of four wild horse populations, both Nunez et al. (2009) and Ransom et al. (2010) found that PZP-treated mares were involved in reproductive interactions with stallions more often than control mares, which is not surprising given the evidence that PZP-treated females of other mammal species can regularly demonstrate estrus behavior while contracepted (Shumake and Killian 1997, Heilmann et al. 1998, Curtis et al. 2001). There was no evidence, though, that mare welfare was affected by the increased level of herding by stallions noted in Ransom et al. (2010). Nunez's later analysis (2017) noted no difference in mare reproductive behavior as a function of contraception history.

Ransom et al. (2010) found that control mares were herded by stallions more frequently than PZP-treated mares, and Nunez et al. (2009, 2014, 2017) found that PZP-treated mares exhibited higher infidelity to their band stallion during the non-breeding season than control mares. Madosky et al. (2010) and Knight (2014) found this infidelity was also evident during the breeding season in the same population that Nunez et al. (2009, 2010, 2014, 2017) studied; they concluded that PZP-treated mares changing bands more frequently than control mares could lead to band instability. Nunez et al. (2009), though, cautioned against generalizing from that island population to other herds. Nuñez et al. (2014) found elevated levels of fecal cortisol, a marker of physiological stress, in mares that changed bands. The research is inconclusive as to whether all the mares' movements between bands were related to the PZP treatments themselves or the fact that the mares were not nursing a foal, and did not demonstrate any long-term negative consequence of the transiently elevated cortisol levels. The authors (Nunez et al. 2014) concede that these effects "…may be of limited concern when population reduction is an urgent priority." In contrast to transient stresses, Creel et al (2013) highlight that variation in population density is one of the most well-established causal factors of chronic activation of the hypothalamic-pituitary-adrenal axis, which mediates stress hormones; high population densities and competition for resources can cause chronic stress. Creel also states that "…there is little consistent evidence for a negative association between elevated baseline glucocorticoids and fitness." Band fidelity is not an aspect of wild horse biology that is specifically protected by the WFRHBA of 1971. It is also notable that Ransom et al. (2014b) found higher group fidelity after a herd had been gathered and treated with a contraceptive vaccine; in that case, the researchers postulated that higher fidelity may have been facilitated by the decreased competition for forage after excess horses were removed. At the population level, available research does not provide evidence of the loss of harem structure among any herds treated with PZP. Long-term implications of these changes in social behavior are currently unknown, but no negative impacts on the overall animals or populations welfare or well-being have been noted in these studies.

The National Research Council (2013) found that harem changing was not likely to result in serious adverse effects for treated mares:

> "The studies on Shackleford Banks (Nuñez et al., 2009; Madosky et al., 2010) suggest that there is an interaction between pregnancy and social cohesion. The importance of harem stability to mare well-being is not clear, but considering the relatively large number of free-ranging mares that have been treated with liquid PZP in a variety of ecological settings, the likelihood of serious adverse effects seem low."

Nunez (2010) stated that not all populations will respond similarly to PZP treatment. Differences in habitat, resource availability, and demography among conspecific populations will undoubtedly affect their physiological and behavioral responses to PZP contraception, and need to be considered. Kirkpatrick et al. (2010) concluded that: "the larger question is, even if subtle alterations in behavior may occur, this is still far better than the alternative*,"* and that the "…other victory for horses is that every mare prevented from being removed, by virtue of contraception, is a mare that will only be delaying her reproduction rather than being eliminated permanently from the range. This preserves herd genetics, while gathers and adoption do not."

The NRC report (2013) provides a comprehensive review of the literature on the behavioral effects of contraception that put research up to that date by Nuñez et al. (2009, 2010) into the broader context of all of the available scientific literature, and cautions, based on its extensive review of the literature that:

> ". . . in no case can the committee conclude from the published research that the behavior differences observed are due to a particular compound rather than to the fact that treated

animals had no offspring during the study. That must be borne in mind particularly in interpreting long-term impacts of contraception (e.g., repeated years of reproductive “failure” due to contraception).”

Genetic Effects of PZP Vaccination

In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NRC report recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, such that most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NRC 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result which would be expected to slow the rate of genetic diversity loss (Hailer et al., 2006). Based on a population model, Gross (2000) found that an effective way to retain genetic diversity in a population treated with fertility control is to preferentially treat young animals, such that the older animals (which contain all the existing genetic diversity available) continue to have offspring. Conversely, Gross (2000) found that preferentially treating older animals (preferentially allowing young animals to breed) leads to a more rapid expected loss of genetic diversity over time.

Even if it is the case that repeated treatment with PZP may lead to prolonged infertility, or even sterility in some mares, most HMAs have only a low risk of loss of genetic diversity if logistically realistic rates of contraception are applied to mares. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses. As such, the existing genetic diversity in the majority of HMAs does not contain unique or historically unusual genetic markers. Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e. human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition. Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in case where starting levels of genetic diversity are low, initial population size is 100 or less, and the intrinsic population growth rate is low (5% per year), and very large fractions of the female population are permanently sterilized.

Many factors influence the strength of a vaccinated individual’s immune response, potentially including genetics, but also nutrition, body condition, and prior immune responses to pathogens or other antigens (Powers et al. 2013). One concern that has been raised with regards to genetic diversity is that treatment with immunocontraceptives could possibly lead to an evolutionary increase in the frequency of individuals whose genetic composition fosters weak immune responses (Cooper and Larson 2006, Ransom et al. 2014a). This premise is based on an assumption that lack of response to PZP is a heritable trait, and that the frequency of that trait will increase over time in a population of PZP-treated animals. Cooper and Herbert (2001) reviewed the topic, in the context of concerns about the long-term effectiveness of immunocontraceptives as a control agent for exotic species in Australia. They argue that imunocontraception could be a strong selective pressure, and that selecting for reproduction in individuals with poor immune response could lead to a general decline in immune function in populations where such evolution takes place. Other authors have also speculated that differences in antibody titer responses could be partially due to genetic differences between animals (Curtis et al. 2001, Herbert and Trigg 2005). Although this topic may merit further study, lack of clarity should not preclude the use of immunocontraceptives to help stabilize extremely rapidly growing herds.

BLM is not aware of any studies that have quantified the heritability of a lack of response to immunocontraception such as PZP vaccine or GonaCon-Equine in horses. At this point there are no studies available from which one could make conclusions about the long-term effects of sustained and widespread immunocontraception treatments on population-wide immune function. Although a few, generally isolated, feral horse populations have been treated with high fractions of mares receiving PZP immunocontraception for long-term population control (e.g., Assateague Island and Pryor Mountains), no studies have tested for changes in immune competence in those areas. Relative to the large number of free-roaming feral horses in the western United States, immunocontraception has not been used in the type of widespread or prolonged manner that might be required to cause a detectable evolutionary response.

Magiafolou et al. (2013) clarify that if the variation in immune response is due to environmental factors (i.e., body condition, social rank) and not due to genetic factors, then there will be no expected effect of the immune phenotype on future generations. It is possible that general health, as measured by body condition, can have a causal role in determining immune response, with animals in poor condition demonstrating poor immune reactions (NRC 2013).

Correlations between such physical factors and immune response would not preclude, though, that there could also be a heritable response to immunocontraception. In studies not directly related to immunocontraception, immune response has been shown to be heritable (Kean et al. 1994, Sarker et al. 1999). Unfortunately, predictions about the long-term, population-level evolutionary response to immunocontraceptive treatments are speculative at this point, with results likely to depend on several factors, including: the strength of the genetic predisposition to not respond to PZP; the heritability of that gene or genes; the initial prevalence of that gene or genes; the number of mares treated with a primer dose of PZP (which generally has a short-acting effect); the number of mares treated with multiple booster doses of PZP; and the actual size of the genetically-interacting metapopulation of horses within which the PZP treatment takes place.

GONACON

BLM Use of Contraception in Wild Horse Management
It is a BLM priority to expand the use of population growth suppression (PGS) to slow population growth rates and reduce the number of animals removed from the range and sent to off-range pastures (ORPs). The WFRHBA of 1971 specifically provides for contraception and sterilization

(section 3.b.1). No finding of excess animals is required for BLM to pursue contraception in wild horses or wild burros. Contraception has been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used with other techniques, to reduce horse population size (Bartholow, 2004; de Seve and Boyles-Griffin, 2013). All fertility control methods in wild animals are associated with potential risks and benefits, including costs, effects of handling, frequency of handling, physiological effects, behavioral effects, reduced population growth rates (Hampton et al. 2015), and population genetics effects. Contraception by itself does not remove excess horses from an HMA, so if the number of wild horses in an HMA is in excess of AML, then contraception alone would not prevent continuing environmental effects of horse overpopulation, at least not in the short term. Successful contraception reduces future reproduction. Limiting future population increases of horses would limit increases in environmental damage from higher densities of horses. Horses are long-lived, potentially reaching 20 years of age or more in the wild and, if the population is above AML, treated horses returned to the HMA may continue exerting negative environmental effects, as described in the effects section above, throughout their life span. In contrast, if horses above AML are removed when horses are gathered, one result can be an immediate decrease in the severity of ongoing detrimental environmental effects.

Successful contraception would be expected to reduce the effects of frequent horse gather activities on the environment, as well as to reduce wild horse management costs to taxpayers. Bartholow (2007) concluded that the application of 2 or 3-year contraceptives to wild mares could reduce operational costs in a project area by 12-20%, or up to 30% in carefully planned population management programs. He also concluded that contraceptive treatment would likely reduce the number of horses that must be removed in total, with attendant cost reductions in the number of adoptions and total holding costs. If application of contraception to horses requires capturing and handling horses, the risks and costs associated with capture and handling of horses may be comparable to those of gathering for removal, but with expectedly lower adoption and long-term holding costs. Population suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000). Selectively applying contraception to older animals and returning them to the HMA could reduce long-term holding costs for such horses, which are difficult to adopt, and could negate the compensatory reproduction that can follow removals (Kirkpatrick and Turner 1991). On the other hand, selectively applying contraception to younger animals can slow the rate of genetic diversity loss – a process that tends to be slow in a long-lived animal with high levels of genetic diversity – and could reduce growth rates further by delaying the age of first parturition (Gross 2000). Although contraceptive treatments may be associated with a number of potential physiological, behavioral, demographic, and genetic effects, detailed below, those concerns do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013).

The literature review is intended to summarize what is known and what is not known about potential effects of treating mares with GonaCon. As noted below, some negative consequences of vaccination are possible. Anti-GnRH vaccines can be administered to either sex, but this analysis is limited to effects on females, except where inferences can be made to females, based on studies that have used the vaccine in males.

Whether to use or not use this method to reduce population growth rates in wild horses is a decision that must be made considering those effects as well as the potential effects of inaction, such as continued overpopulation and rangeland health degradation.

Reference in this text to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement, recommendation, or favoring by the Department of the Interior.

1 Gonadotropin Releasing Hormone (GnRH) Vaccine

1.1 Registration and safety of GonaCon-Equine

The immune-contraceptive GonaCon-Equine vaccine meets most of the criteria that the National Research Council of the National Academy of Sciences (NRC 2013) used to identify the most promising fertility control methods, in terms of delivery method, availability, efficacy, and side effects. GonaCon-Equine is approved for use by authorized federal, state, tribal, public and private personnel, for application to wild and feral equids in the United States (EPA 2013, 2015). Its use is appropriate for free-ranging wild horse herds. Taking into consideration available literature on the subject, the National Research Council concluded in their 2013 report that GonaCon-B (which is produced under the trade name GonaCon-Equine for use in feral horses and burros) was one of the most preferable available methods for contraception in wild horses and burros (NRC 2013). GonaCon-Equine has been used on feral horses in Theodore Roosevelt National Park and on wild horses in one BLM-administered HMA (BLM 2015). GonaCon-Equine can be remotely administered in the field in cases where mares are relatively approachable, using a customized pneumatic dart (McCann et al. 2017). Use of remotely delivered (dart-delivered) vaccine is generally limited to populations where individual animals can be accurately identified and repeatedly approached within 50 m (BLM 2010).

As with other contraceptives applied to wild horses, the long-term goal of GonaCon-Equine use is to reduce or eliminate the need for gathers and removals (NRC 2013). GonaCon-Equine vaccine is an EPA-approved pesticide (EPA, 2009a) that is relatively inexpensive, meets BLM requirements for safety to mares and the environment, and is produced in a USDA-APHIS laboratory. Its categorization as a pesticide is consistent with regulatory framework for controlling overpopulated vertebrate animals, and in no way is meant to convey that the vaccine is lethal; the intended effect of the vaccine is as a contraceptive. GonaCon is produced as a pharmaceutical-grade vaccine, including aseptic manufacturing technique to deliver a sterile vaccine product (Miller et al. 2013). If stored at 4° C, the shelf life is 6 months (Miller et al 2013).

Miller et al. (2013) reviewed the vaccine environmental safety and toxicity. When advisories on the product label (EPA 2015) are followed, the product is safe for users and the environment (EPA 2009b). EPA waived a number of tests prior to registering the vaccine, because GonaCon was deemed to pose low risks to the environment, so long as the product label is followed (Wang-Chaill et al. 2017, *in press*).

Under the Proposed Action, the BLM would return to the HMA as needed to re-apply GonaCon-Equine and initiate new treatments in order to maintain contraceptive effectiveness in controlling population growth rates. GonaCon-Equine can safely be reapplied as necessary to control the population growth rate. Even with one booster treatment of GonaCon-Equine, it is expected that most, if not all, mares would return to fertility at some point, although the average duration of effect after booster doses has not yet been quantified. It is unknown what would be the expected rate for the return to fertility rate in mares boosted more than once with GonaCon-Equine. Once the herd size in the project area is at AML and population growth seems to be stabilized, BLM could make a determination as to the required frequency of new mare treatments and mare re-treatments with GonaCon, to maintain the number of horses within AML.

1.2 GnRH Vaccine Direct Effects

GonaCon-Equine is one of several vaccines that have been engineered to create an immune response to the gonadotropin releasing hormone peptide (GnRH). GnRH is a small peptide that plays an important role in signaling the production of other hormones involved in reproduction in both sexes. GnRH is highly conserved across mammalian taxa, so some inferences about the mechanism and effects of GonaCon-Equine in horses can be made from studies that used different anti-GnRH vaccines, in horses and other taxa. Other anti-GnRH vaccines include: Improvac (Imboden et al. 2006, Botha et al. 2008, Janett et al. 2009, Schulman et al. 2013, Dalmau et al. 2015), made in South Africa; Equity (Elhay et al. 2007), made in Australia; Improvest, for use in swine (Bohrer et al. 2014); Repro-BLOC (Boedeker et al. 2011); and Bopriva, for use in cows (Balet et al. 2014). Of these, GonaCon-Equine, Improvac, and Equity are specifically intended for horses. Other anti-GnRH vaccine formulations have also been tested, but did not become trademarked products (e.g., Goodloe 1991, Dalin et al 2002, Stout et al. 2003, Donovan et al. 2013). The effectiveness and side-effects of these various anti-GnRH vaccines may not be the same as would be expected from GonaCon-Equine use in horses. Results could differ as a result of differences in the preparation of the GnRH antigen, and the choice of adjuvant used to stimulate the immune response. While GonaCon-Equine can be administered as a single dose, most other anti-GnRH vaccines require a primer dose and at least one booster dose to be effective.

GonaCon has been produced by USDA-APHIS (Fort Collins, Colorado) in several different formulations, the history of which is reviewed by Miller et al. (2013). In any vaccine, the antigen is the stimulant to which the body responds by making antigen-specific antibodies. Those antibodies then signal to the body that a foreign molecule is present, initiating an immune response that removes the molecule or cell. GonaCon vaccines present the recipient with hundreds of copies of GnRH as peptides on the surface of a linked protein that is naturally antigenic because it comes from invertebrate hemocyanin (Miller et al 2013). Early GonaCon formulations linked many copies of GnRH to a protein from the keyhole limpet [GonaCon-KHL], but more recently produced formulations where the GnRH antigen is linked to a protein from the blue mussel [GonaCon-B] proved less expensive and more effective (Miller et al. 2008). GonaCon-Equine is in the category of GonaCon-B vaccines.

Adjuvants are included in vaccines to elevate the level of immune response, inciting recruitment of lymphocytes and other immune cells which foster a long-lasting immune response that is specific to the antigen. For some formulations of anti-GnRH vaccines, a booster dose is required to elicit at contraceptive response, though GonaCon can cause short-term contraception in a fraction of treated animals from one dose (Powers et al. 2011, Gionfriddo et al. 2011a, Baker et al. 2013, Miller et al 2013). The adjuvant used in GonaCon, Adjuvac, generally leads to a milder reaction than Freunds complete adjuvant (Powers et al. 2011). Adjuvac contains a small number of killed *Mycobacterium avium* cells (Miller et al. 2008, Miller et al. 2013). The antigen and adjuvant are emulsified in mineral oil, such that they are not all presented to the immune system right after injection; it is thought that the mineral oil emulsion leads to a depot effect and longer-lasting immune response (Miller et al. 2013). Miller et al. (2008, 2013) have speculated that, in cases where memory-B leukocytes are protected in immune complexes in the lymphatic system, it can lead to years of immune response. Increased doses of vaccine may lead to stronger immune reactions, but only to a certain point; when Yoder and Miller (2010) tested varying doses of GonaCon in prairie dogs, antibody responses to the 200µg and 400µg doses were equal to each other but were both higher than in response to a 100µg dose.

The most direct result of successful GnRH vaccination is that it has the effect of decreasing the level of GnRH signaling in the body, as evidenced by a drop in lueinizing hormone levels, and a cessation of ovulation. Antibody titer measurements are proximate measures of the antibody concentration in the blood specific to a given antigen. Anti-GnRH titers generally correlate with a suppressed reproduction system (Gionfriddo et al. 2011a, Powers et al. 2011). Various studies have attempted to identify a relationship between anti-GnRH titer levels and infertility, but that relationship has not been universally predictable or consistent. The time length that titer levels stay high appears to correlate with the length of suppressed reproduction (Dalin et al. 2002, Levy et al. 2011, Donovan et al. 2013, Powers et al. 2011). For example, Goodloe (1991) noted that mares did produce elevated titers and had suppressed follicular development for 11-13 weeks after treatment, but that all treated mares ovulated after the titer levels declined. Similarly, Elhay (2007) found that high initial titers correlated with longer-lasting ovarian and behavioral anoestrus. However, Powers et al. (2011) did not identify a threshold level of titer that was consistently indicative of suppressed reproduction despite seeing a strong correlation between antibody concentration and infertility, nor did Schulman et al. (2013) find a clear relationship between titer levels and mare acyclicity.

In many cases, young animals appear to have higher immune responses, and stronger contraceptive effects of anti-GnRH vaccines than older animals (Brown et al. 1994, Curtis et al. 2001, Stout et al. 2003, Schulman et al. 2013). Vaccinating with GonaCon at too young an age, though, may prevent effectiveness; Gionfriddo et al. (2011a) observed weak effects in 3-4 month old fawns. It has not been possible to predict which individuals of a given age class will have long-lasting immune responses to the GonaCon vaccine. Gray (2010) noted that mares in poor body condition tended to have lower contraceptive efficacy in response to GonaCon-B. Miller et al. (2013) suggested that higher parasite loads might have explained a lower immune response in free-roaming horses than had been observed in a captive trial. At this time it is unclear what the most important factors affecting efficacy are.

Females that are successfully contracepted by GnRH vaccination enter a state similar to anestrus, have a lack of or incomplete follicle maturation, and no ovarian cycling (Botha et al. 2008). A leading hypothesis is that anti-GnRH antibodies bind GnRH in the hypothalamus – pituitary 'portal vessels,' preventing GnRH from binding to GnRH-specific binding sites on gonadotroph cells in the pituitary, thereby limiting the production of gonadotropin hormones, particularlyleutinizing hormone [LH] and, to a lesser degree, follicle-stimulating hormone [FSH] (Powers et al. 2011, NRC 2013). This reduction in LH (and FSH), and a corresponding lack of ovulation, has been measured in response to treatment with anti-GnRH vaccines (Boedeker et al. 2011, Garza et al. 1986).

Females successfully treated with anti-GnRH vaccines have reduced progesterone levels (Garza et al 1986, Stout et al. 2003, Imboden et al. 2006, Elhay 2007, Botha et al. 2008, Killian et al. 2008, Miller et al. 2008, Janett et al. 2009, Schulman et al. 2013, Balet et al 2014, Dalmau et al. 2015) and β-17 estradiol levels (Elhay et al. 2007), but no great decrease in estrogen levels (Balet et al. 2014). Reductions in progesterone do not occur immediately after the primer dose, but can take several weeks or months to develop (Elhay et al 2007, Botha et al. 2008, Schulman et al. 2013, Dalmau et al. 2015). This indicates that ovulation is not occurring and corpora lutea, formed from post-ovulation follicular tissue, are not being established.

Changes in hormones associated with anti-GnRH vaccination lead to measurable changes in ovarian structure and function. The volume of ovaries reduced in response to treatment (Garza et al. 1986, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Botha et al. 2008, Gionfriddo 2011a, Dalmau et al. 2015). Treatment with an anti-GnRH vaccine changes follicle development (Garza et al. 1986, Stout et al. 2003, Imboden et al. 2006, Elhay et al. 2007, Donovan et al. 2013, Powers et al. 2011, Balet et al 2014), with the result that ovulation does not occur. A related result is that the ovaries can exhibit less activity and cycle with less regularity or not at all in anti-GnRH vaccine treated females (Goodloe 1991, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Janett et al. 2009, Donovan et al. 2013, Powers et al. 2011). In studies where the vaccine required a booster, this result was generally observed within several weeks after delivery of the booster dose.

1.2 GnRH Vaccine Contraceptive Effects

The NRC (2013) review pointed out that single doses of GonaCon-Equine do not lead to high rates of initial effectiveness, or long duration. Initial effectiveness of one dose of GonaCon-Equine vaccine appears to be lower than for a combined primer plus booster dose of the PZP vaccine Zonastat-H (Kirkpatrick et al. 2011), and the initial effect of a single GonaCon dose can be limited to as little as one breeding season. However, preliminary results on the effects of boostered doses of GonaCon-Equine indicate that it can have high efficacy and longer-lasting effects in free-roaming horses (Baker et al. 2017) than the one-year effect that is generally expected from a single booster of Zonastat-H.

GonaCon and other anti-GnRH vaccines can be injected while a female is pregnant (Miller et al. 2000, Powers et al. 2011, Baker et al. 2013) – in such a case, a successfully contracepted mare will be expected to give birth during the following foaling season, but to be infertile during the same year’s breeding season. Thus, a mare injected in November of 2018 would not show the contraceptive effect (i.e., no new foal) until spring of 2020.

Too few studies have reported on the various formulations of anti-GnRH vaccines to make generalizations about differences between products, but GonaCon formulations were consistently good at causing loss of fertility in a statistically significant fraction of treated mares for at least one year (Killian et al. 2009, Gray et al. 2010, Baker et al. 2013, 2017). With few exceptions (e.g., Goodloe 1991), anti-GnRH treated mares gave birth to fewer foals in the first season when there would be an expected contraceptive effect (Botha et al. 2008, Killian et al. 2009, Gray et al. 2010, Baker et al. 2013). Goodloe (1991) used an anti-GnRH-KHL vaccine with a triple adjuvant, in some cases attempting to deliver the vaccine to horses with a hollow-tipped ‘biobullet, ’but concluded that the vaccine was not an effective immunocontraceptive in that study.

Not all mares should be expected to respond to the GonaCon-equine vaccine; some number should be expected to continue to become pregnant and give birth to foals. In studies where mares were exposed to stallions, the fraction of treated mares that are effectively contracepted in the year after anti-GnRH vaccination varied from study to study, ranging from ~50% (Baker et al. 2017), to 61% (Gray et al. 2010) to ~90% (Killian et al. 2006, 2008, 2009). Miller et al. (2013) noted lower effectiveness in free-ranging mares (Gray et al. 2010) than captive mares (Killian et al. 2009). Some of these rates are lower than the high rate of effectiveness typically reported for the first year after PZP vaccine treatment (Kirkpatrick et al. 2011). In the one study that tested for a difference, darts and hand-injected GonaCon doses were equally effective in terms of fertility outcome (McCann et al. 2017).

In studies where mares were not exposed to stallions, the duration of effectiveness also varied. A primer and booster dose of Equity led to anoestrus for at least 3 months (Elhay et al 2007). A primer and booster dose of Improvac also led to loss of ovarian cycling for all mares in the short term (Imboden et al. 2006). It is orth repeating that those vaccines do not have the same formulation as GonaCon.

Results from horses (Baker et al. 2017) and other species (Curtis et al. 2001) suggest that providing a booster dose of GonaCon-Equine will increase the fraction of temporarily infertile animals to higher levels than would a single vaccine dose alone.

Longer-term infertility has been observed in some mares treated with anti-GnRH vaccines, including GonaCon-Equine. In a single-dose mare captive trial with an initial year effectiveness of 94%, Killian et al. (2008) noted infertility rates of 64%, 57%, and 43% in treated mares during the following three years, while control mares in those years had infertility rates of 25%, 12% and 0% in those years. GonaCon effectiveness in free-roaming populations was lower, with infertility rates consistently near 60% for three years after a single dose in one study (Gray et al. 2010) and annual infertility rates decreasing over time from 55% to 30% to 0% in another study with one dose (Baker et al. 2017). Similarly, gradually increasing fertility rates were observed after single dose treatment with GonaCon in elk (Powers et al. 2011) and deer (Gionfriddo et al. 2011a).

Baker et al. (2017) observed a return to fertility over 4 years in mares treated once with GonaCon, but then noted extremely low fertility rates of 0% and 16% in the two years after the same mares were given a booster dose four years after the primer dose. These are extremely promising preliminary results from that study in free-roaming horses; a third year of post-booster monitoring is ongoing in summer 2017, and researchers on that project are currently determining whether the same high-effectiveness, long-term response is observed after boosting with GonaCon after 6 months, 1 year, 2 years, or 4 years after the primer dose. Four of nine mares treated with primer and booster doses of Improvac did not return to ovulation within 2 years of the primer dose (Imboden et al. 2006), though one should probably not make conclusions about the long-term effects of GonaCon-Equine based on results from Improvac.

It is difficult to predict which females will exhibit strong or long-term immune responses to anti-GnRH vaccines (Killian et al. 2006, Miller et al. 2008, Levy et al. 2011). A number of factors may influence responses to vaccination, including age, body condition, nutrition, prior immune responses, and genetics (Cooper and Herbert 2001, Curtis et al. 2001, Powers et al. 2011). One apparent trend is that animals that are treated at a younger age, especially before puberty, may have stronger and longer-lasting responses (Brown et al. 1994, Curtis et al. 2001, Stout et al. 2003, Schulman et al. 2013). It is plausible that giving ConaGon-Equine to prepubertal mares will lead to long-lasting infertility, but that has not yet been tested.

To date, short term evaluation of anti-GnRH vaccines, show contraception appears to be temporary and reversible. Killian et al. noted long-term effects of GonaCon in some captive mares (2009). However, Baker et al. (2017) observed horses treated with GonaCon-B return to fertility after they were treated with a single primer dose; after four years, the fertility rate was indistinguishable between treated and control mares. It appears that a single dose of GonaCon results in reversible infertility but it is unknown if long term treatment would result in permanent infertility.

Other anti-GnRH vaccines also have had reversible effects in mares. Elhay (2007) noted a return to ovary functioning over the course of 34 weeks for 10 of 16 mares treated with Equity. That study ended at 34 weeks, so it is not clear when the other six mares would have returned to fertility. Donovan et al. (2013) found that half of mares treated with an anti-GnRH vaccine intended for dogs had returned to fertility after 40 weeks, at which point the study ended. In a study of mares treated with a primer and booster dose of Improvac, 47 of 51 treated mares had returned to ovarian cyclicity within 2 years; younger mares appeared to have longer-lasting effects than older mares (Schulman et al. 2013). In a small study with a non-commercial anti-GnRH vaccine (Stout et al. 2003), three of seven treated mares had returned to cyclicity within 8 weeks after delivery of the primer dose, while four others were still suppressed for 12 or more weeks. In elk, Powers et al. (2011) noted that contraception after one dose of GonaCon was reversible. In white-tailed deer, single doses of GonaCon appeared to confer two years of contraception (Miller et al. 2000). Ten of 30 domestic cows treated became pregnant within 30 weeks after the first dose of Bopriva (Balet et al. 2014).

Permanent sterility as a result of single-dose or boostered GonaCon-Equine vaccine, or other anti-GnRH vaccines, has not been recorded, but that may be because no long-term studies have tested for that effect. It is conceivable that some fraction of mares could become sterile after receiving one or more booster doses of GonaCon-Equine, but the rate at which that could be expected to occur is currently unknown. If some fraction of mares treated with GonaCon-Equine were to become sterile, though, that result would not be contrary to the WFRHBA of 1971, as amended.

In summary, based on the above results related to fertility effects of GonaCon and other anti-GnRH vaccines, application of a single dose of GonaCon-Equine to gathered wild horses could be expected to prevent pregnancy in perhaps 30%-60% of mares for one year. Some smaller number of wild mares should be expected to have persistent contraception for a second year, and less still for a third year. Applying one booster dose of GonaCon to previously-treated mares should lead to two or more years with relatively high rates (80+%) of additional infertility expected, with the potential that some as-yet-unknown fraction of boostered mares may be infertile for several to many years. There is no data to support speculation regarding efficacy of multiple boosters of GonaCon-Equine; however, given it is formulated as a highly immunogenic long-lasting vaccine, it is reasonable to hypothesize that additional boosters would increase the effectiveness and duration of the vaccine.

GonaCon-Equine only affects the fertility of treated animals; untreated animals will still be expected to give birth. Even under favorable circumstances for population growth suppression, gather efficiency might not exceed 85% via helicopter, and may be less with bait and water trapping. The uncaptured portion of the female population would still be expected to have normally high fertility rates in any given year, though those rates could go up slightly if contraception in other mares increases forage and water availability.

1.3 GnRH Vaccine Effects on Other Organ Systems

Mares receiving any vaccine would experience slightly increased stress levels associated with handling while being vaccinated and freeze-marked, and potentially microchipped. Newly captured mares that do not have markings associated with previous fertility control treatments would be marked with a new freeze-mark for the purpose of identifying that mare, and identifying her vaccine treatment history. This information would also be used to determine the number of mares captured that were not previously treated, and could provide additional insight regarding gather efficiency.

Most mares recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from the fertility control injections, other than the direct consequence of becoming temporarily infertile.

Injection site reactions associated with immunocontraceptive treatments are possible in treated mares (Roelle and Ransom 2009). Whether injection is by hand or via darting, GonaCon-Equine is associated with some degree of inflammation, swelling, and the potential for abscesses at the injection site (Baker et al. 2013). Swelling or local reactions at the injection site are generally expected to be minor in nature, but some may develop into draining abscesses. When PZP vaccine was delivered via dart it led to more severe swelling and injection site reactions (Roelle and Ransom 2009), but that was not observed with dart-delivered GonaCon (McCann et al. 2017). Mares treated with one formulation of GnRH-KHL vaccine developed pyogenic abscesses (Goodloe 1991). Miller et al. (2008) noted that the water and oil emulsion in GonaCon will often cause cysts, granulomas, or sterile abscesses at injection sites; in some cases, a sterile abscess may develop into a draining abscess. In elk treated with GonaCon, Powers et al. (2011) noted up to 35% of treated elk had an abscess form, despite the injection sites first being clipped and swabbed with alcohol. Even in studies where swelling and visible abscesses followed GonaCon immunization, the longer term nodules observed did not appear to change any animal's range of movement or locomotor patterns (Powers et al. 2013, Baker et al. 2017).

The result that other formulations of anti-GnRH vaccine may be associated with less notable injection site reactions in horses may indicate that the adjuvant formulation in GonaCon leads a single dose to cause a stronger immune reaction than the adjuvants used in other anti-GnRH vaccines. Despite that, a booster dose of GonaCon-Equine appears to be more effective than a primer dose alone (Baker et al. 2017). Horses injected in the hip with Improvac showed only transient reactions that disappeared within 6 days in one study (Botha et al. 2008), but stiffness and swelling that lasted 5 days were noted in another study where horses received Improvac in the neck (Imboden et al. 2006). Equity led to transient reactions that resolved within a week in some treated animals (Elhay et al. 2007). Donovan et al. noted no reactions to the canine anti-GnRH vaccine (2013). In cows treated with Bopriva there was a mildly elevated body temperature and mild swelling at injection sites that subsided within 2 weeks (Balet et al. 2014).

Several studies have monitored animal health after immunization against GnRH. GonaCon treated mares did not have any measurable difference in uterine edema (Killian 2006, 2008). Powers et al. (2011, 2013) noted no differences in blood chemistry except a mildly elevated fibrinogen level in some GonaCon treated elk. In that study, one sham-treated elk and one GonaCon treated elk each developed leukocytosis, suggesting that there may have been a causal link between the adjuvant and the effect. Curtis et al. (2008) found persistent granulomas at GonaCon-KHL injection sites three years after injection, and reduced ovary weights in treated females. Yoder and Miller (2010) found no difference in blood chemistry between GonaCon treated and control prairie dogs. One of 15 GonaCon treated cats died without explanation, and with no determination about cause of death possible based on necropsy or histology (Levy et al. 2011). Other anti-GnRH vaccine formulations have led to no detectable adverse effects (in elephants; Boedeker et al. 2011), though Imboden et al. (2006) speculated that young treated animals might conceivably have impaired hypothamic or pituitary function.

Kirkpatrick et al. (2011) raised concerns that anti-GnRH vaccines could lead to adverse effects in other organ systems outside the reproductive system. GnRH receptors have been identified in tissues outside of the pituitary system, including in the testes and placenta (Khodr and Siler-Khodr 1980), ovary (Hsueh and Erickson 1979), bladder (Coit et al. 2009), heart (Dong et al. 2011), and central nervous system, so it is plausible that reductions in circulating GnRH levels could inhibit physiological processes in those organ systems. Kirkpatrick et al. (2011) noted elevated cardiological risks to human patients taking GnRH agonists (such as leuprolide), but the National Academy of Sciences (2013) concluded that the mechanism and results of GnRH agonists would be expected to be different from that of anti-GnRH antibodies; the former flood GnRH receptors, while the latter deprive receptors of GnRH.

1.4 GnRH Vaccine Effects on Fetus and Foal

Although fetuses are not explicitly protected under the WFRHBA of 1971, as amended, it is prudent to analyze the potential effects of GonaCon-Equine or other anti-GnRH vaccines on developing fetuses and foals. GonaCon had no apparent effect on pregnancies in progress, foaling success, or the health of offspring, in horses that were immunized in October (Baker et al. 2013), elk immunized 80-100 days into gestation (Powers et al. 2011, 2013), or deer immunized in February (Miller et al. 2000). Kirkpatrick et al. (2011) noted that anti-GnRH immunization is not expected to cause hormonal changes that would lead to abortion in the horse, but this may not be true for the first 6 weeks of pregnancy (NRC 2013). Curtis et al. (2011) noted that GonaCon-KHL treated white tailed deer had lower twinning rates than controls, but speculated that the difference could be due to poorer sperm quality late in the breeding season, when the treated does did become pregnant. Goodloe (1991) found no difference in foal production between treated and control animals.

Offspring of anti-GnRH vaccine treated mothers could exhibit an immune response to GnRH (Khodr and Siler-Khodr 1980), as antibodies from the mother could pass to the offspring through the placenta or colostrum. In the most extensive study of long-term effects of GonaCon immunization on offspring, Powers et al. (2012) monitored 15 elk fawns born to GonaCon treated cows. Of those, 5 had low titers at birth and 10 had high titer levels at birth. All 15 were of normal weight at birth, and developed normal endocrine profiles, hypothalamic GnRH content, pituitary gonadotropin content, gonad structure, and gametogenesis. All the females became pregnant in their second reproductive season, as is typical. All males showed normal development of secondary sexual characteristics. Powers et al. (2012) concluded that suppressing GnRH in the neonatal period did not alter long-term reproductive function in either male or female offspring. Miller et al. (2013) report elevated anti-GnRH antibody titers in fawns born to treated white tailed deer, but those dropped to normal levels in 11 of 12 of those fawns, which came into breeding condition; the remaining fawn was infertile for three years.

Direct effects on foal survival are equivocal in the literature. Goodloe (1991), reported lower foal survival for a small sample of foals born to anti-GnRH treated mares, but she did not assess other possible explanatory factors such as mare social status, age, body condition, or habitat in her analysis (NRC 2013). Gray et al. (2010) found no difference in foal survival in foals born to free-roaming mares treated with GonaCon.

There is little empirical information available to evaluate the effects of GnRH vaccination on foaling phenology. It is possible that immunocontracepted mares returning to fertility late in the breeding season could give birth to foals at a time that is out of the normal range (Nunez et al. 2010, Ransom et al 2013). Curtis et al. (2001) did observe a slightly later fawning date for GonaCon treated deer in the second year after treatment, when some does regained fertility late in the breeding season. In anti-GnRH vaccine trials in free-roaming horses, there were no published differences in mean date of foal production (Goodloe 1991, Gray et al. 2010). Unpublished results from an ongoing study of GonaCon treated free-roaming mares indicate that some degree of seasonal foaling is possible (D. Baker, Colorado State University, personal communication to Paul Griffin, BLM WH&B Research Coordinator). Because of the concern that contraception could lead to shifts in the timing of parturitions for some treated animals, Ransom et al. (2013) advised that managers should consider carefully before using PZP immunocontraception in small refugia or rare species. Wild horses and burros in most areas do not generally occur in isolated refugia, they are not a rare species at the regional, national, or international level, and genetically they represent descendants of domestic livestock with most populations containing few if any unique alleles (NAS 2013). Moreover, in PZP-treated horses that did have some degree of parturition date shift, Ransom et al. (2013) found no negative impacts on foal survival even with an extended birthing season; however, this may be more related to stochastic, inclement weather events than extended foaling seasons. If there were to be a shift in foaling date for some treated mares, the effect on foal survival may depend on weather severity and local conditions; for example, Ransom et al. (2013) did not find consistent effects across study sites.

1.5 Indirect Effects of GnRH Vaccination

One expected long-term, indirect effect on wild horses treated with fertility control would be an improvement in their overall health. Many treated mares would not experience the biological stress of reproduction, foaling and lactation as frequently as untreated mares, and their better health is expected to be reflected in higher body condition scores. After a treated mare returns to fertility, her future foals would be expected to be healthier overall, and would benefit from improved nutritional quality in the mares' milk. This is particularly to be expected if there is an improvement in rangeland forage quality at the same time, due to reduced wild horse population size. Past application of fertility control has shown that mares' overall health and body condition can remain improved even after fertility resumes. Anecdotal, subjective observations of mares treated with a different immunocontraceptive, PZP, in past gathers showed that many of the treated mares were larger, maintained better body condition, and had larger healthy foals than untreated mares.

Body condition of anti-GnRH-treated females was equal to or better than that of control females in published studies. Ransom et al. (2014b) observed no difference in mean body condition between GonaCon-B treated mares and controls. Goodloe (1991) found that GnRH-KHL treated mares had higher survival rates than untreated controls. In other species, treated cats gained more weight than controls (Levy et al. 2011), as did treated young female pigs (Bohrer et al. 2014).

Following resumption of fertility, the proportion of mares that conceive and foal could be increased due to their increased fitness; this has been called by some a 'rebound effect.' Elevated fertility rates have been observed after horse gathers and removals (Kirkpatrick and Turner 1991). More research is needed to document and quantify these hypothesized effects; however, it is believed that repeated contraceptive treatment may minimize this postulated rebound effect.

Because successful fertility control would reduce foaling rates and population growth rates, another indirect effect would be to reduce the number of wild horses that have to be removed over time to achieve and maintain the established AML. Contraception would be expected to lead to a relative increase in the fraction of older animals. Reducing the numbers of wild horses that would have to be removed in future gathers could allow for removal of younger, more easily adoptable excess wild horses, and thereby could eliminate the need to send additional excess horses from this area to off-range holding corrals or pastures for long-term holding. A high level of physical health and future reproductive success of fertile mares within the herd would be expected as reduced population sizes should lead to more availability of water and forage resources per capita.

Reduced population growth rates and smaller population sizes could also allow for continued and increased environmental improvements to range conditions within the project area, which would have long-term benefits to wild horse habitat quality. As the local horse abundance nears or is maintained at the level necessary to achieve a thriving natural ecological balance, vegetation resources would be expected to recover, improving the forage available to wild horses and wildlife throughout the HMA or HMAs. With rangeland conditions more closely approaching a thriving natural ecological balance, and with a less concentrated distribution of wild horses across the HMA, there should also be less trailing and concentrated use of water sources. Lower population density would be expected to lead to reduced competition among wild horses using the water sources, and less fighting among horses accessing water sources. Water quality and quantity would continue to improve to the benefit of all rangeland users including wild horses. Wild horses would also have to travel less distance back and forth between water and desirable foraging areas. Should GonaCon-Equine treatment, including booster doses, continue into the future, with treatments given on a schedule to maintain a lowered level of fertility in the herd, the chronic cycle of overpopulation and large gathers and removals might no longer occur, but instead a consistent abundance of wild horses could be maintained, resulting in continued improvement of overall habitat conditions and animal health. While it is conceivable that widespread and continued treatment with GonaCon-Equine could reduce the birth rates of the population to such a point that birth is consistently below mortality, that outcome is not likely unless a very high fraction of the mares present are all treated with primer and booster doses, and perhaps repeated booster doses.

1.6 Behavioral Effects of GnRH Vaccination

Behavioral differences should be considered as potential consequences of contraception with GonaCon. The NRC report (2013) noted that all successful fertility suppression has effects on mare behavior, mostly as a result of the lack of pregnancy and foaling, and concluded that GonaCon was a good choice for use in the program. The result that GonaCon treated mares may have suppressed estrous cycles throughout the breeding season can lead treated mares to behave in ways that are functionally similar to pregnant mares.

While successful in mares, GonaCon and other anti-GnRH vaccines are expected to induce fewer estrous cycles when compared to non-pregnant control mares. This has been observed in many studies (Garza et al. 1986, Curtis et al. 2001, Dalin et al. 2002, Killian et al. 2006, Dalmau et al. 2015). In contrast, PZP vaccine is generally expected to lead mares to have more estrous cycles per breeding season, as they continue to be receptive to mating while not pregnant. Females treated with GonaCon had less estrous cycles than control or PZP-treated mares (Killian et al. 2006) or deer (Curtis et al. 2001). Thus, concerns about PZP treated mares receiving more courting and breeding behaviors from stallions (Nunez et al. 2009, Ransom et al. 2010) are not generally expected to be a concern for mares treated with anti-GnRH vaccines (Botha et al. 2008).

Ransom et al. (2014) found that GonaCon treated mares had similar rates of reproductive behaviors that were similar to those of pregnant mares. Among other potential causes, the reduction in progesterone levels in treated females may lead to a reduction in behaviors associated with reproduction. Despite this, some females treated with GonaCon or other anti-GnRH vaccines did continue to exhibit reproductive behaviors, albeit at irregular intervals and durations (Dalin et al. 2002, Stout et al. 2003, Imboden et al. 2006), which is a result that is similar to spayed (ovariectomized) mares (Asa et al. 1980). Gray et al. (2009) found no difference in sexual behaviors in mares treated with GonaCon and untreated mares. When progesterone levels are low, small changes in estradiol concentration can foster reproductive estrous behaviors (Imboden et al. 2006). Owners of anti-GnRH vaccine treated mares reported a reduced number of estrous-related behaviors under saddle (Donovan et al. 2013). Treated mares may refrain from reproductive behavior even after ovaries return to cyclicity (Elhay et al. 2007). Studies in elk found that GonaCon treated cows had equal levels of precopulatory behaviors as controls (Powers et al. 2011), though bull elk paid more attention to treated cows late in the breeding season, after control cows were already pregnant (Powers et al. 2011).

Stallion herding of mares, and harem switching by mares are two behaviors related to reproduction that might change as a result of contraception. Ransom et al. (2014) observed a 50% decrease in herding behavior by stallions after the free-roaming horse population at Theodore Roosevelt National Park was reduced via a gather, and mares there were treated with GonaCon-B. The increased harem tending behaviors by stallions were directed to both treated and control mores. It is difficult to separate any effect of GonaCon from changes in horse density and forage following horse removals.

Mares in untreated free-roaming populations change bands; some have raised concerns over effects of PZP vaccination on band structure (Nunez et al. 2009), with rates of band fidelity being suggested as a measure of social stability. With respect to treatment with GonaCon or other anti-GnRH vaccines, it is probably less likely that treated mares will switch harems at higher rates than untreated animals, because treated mares are similar to pregnant mares in their behaviors (Ransom et al. 2014). Indeed, Gray et al. (2009) found no difference in band fidelity in a free-roaming population of horses with GonaCon treated mares, despite differences in foal production between treated and untreated mares. Ransom et al. (2014) actually found increased levels of band fidelity after treatment, though this may have been partially a result of changes in overall horse density and forage availability.

Even in cases where there may be changes in band fidelity, the National Research Council's 2013 report titled *Using Science to Improve the BLM Wild Horse and Burro Program* ("NRC Report") found that harem changing was not likely to result in serious adverse effects for treated mares:

> "The studies on Shackleford Banks (Nuñez et al., 2009; Madosky et al., 2010) suggest that there is an interaction between pregnancy and social cohesion. The importance of harem stability to mare well-being is not clear, but considering the relatively large number of free-ranging mares that have been treated with liquid PZP in a variety of ecological settings, the likelihood of serious adverse effects seem low."

Kirkpatrick et al. (2010) concluded that "the larger question is, even if subtle alterations in behavior may occur, this is still far better than the alternative."

The NRC Report (2013) provides a comprehensive review of the literature on the behavioral effects of contraception that puts Dr. Nuñez's (2009, 2010) research into the broader context of all of the available scientific literature, and cautions, based on its extensive review of the literature that:

> ". . . in no case can the committee conclude from the published research that the behavior differences observed are due to a particular compound rather than to the fact that treated animals had no offspring during the study. That must be borne in mind particularly in interpreting long-term impacts of contraception (e.g., repeated years of reproductive

"failure" due to contraception)."

Gray et al. (2009) and Ransom et al. (2014) monitored non-reproductive behaviors in GonaCon treated populations of free-roaming horses. Gray et al. (2009) found no difference between treated and untreated mares in terms of activity budget, sexual behavior, proximity of mares to stallions, or aggression. Ransom et al. (2014) found only minimal differences between treated and untreated mare time budgets, but those differences were consistent with differences in the metabolic demands of pregnancy and lactation in untreated mares, as opposed to non-pregnant treated mares.

1.7 Genetic Effects of GnRH Vaccination

In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NRC report recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, such that most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NRC 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result which would be expected to slow the rate of genetic diversity loss (Hailer et al., 2006). Based on a population model, Gross (2000) found that an effective way to retain genetic diversity in a population treated with fertility control is to preferentially treat young animals, such that the older animals (which contain all the existing genetic diversity available) continue to have offspring. Conversely, Gross (2000) found that preferentially treating older animals (preferentially allowing young animals to breed) leads to a more rapid expected loss of genetic diversity over time.

Even if it is the case that booster treatment with GonaCon may lead to prolonged infertility, or even sterility in some mares, most HMAs have only a low risk of loss of genetic diversity if logistically realistic rates of contraception are applied to mares. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses. As such, the existing genetic diversity in the majority of HMAs does not contain unique or historically unusual genetic markers. Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e. human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition. Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in case where starting levels of genetic diversity are low, initial population size is 100 or less, and the intrinsic population growth rate is low (5% per year), and very large fractions of the female population are permanently sterilized.

Many factors influence the strength of a vaccinated individual's immune response, potentially including genetics, but also nutrition, body condition, and prior immune responses to pathogens or other antigens (Powers et al 2013). One concern that has been raised with regards to genetic diversity is that treatment with immunocontraceptives could possibly lead to an evolutionary increase in the frequency of individuals whose genetic composition fosters weak immune responses (Cooper and Larson 2006, Ransom et al. 2014a). This premise is based on a hypothesis that lack of response to immunocontraceptives could be a heritable trait, and that the frequency of that trait will increase over time in a population of treated animals. Cooper and Herbert (2001) reviewed the topic, in the context of concerns about the long-term effectiveness of immunocontraceptives as a control agent for exotic species in Australia. They argue that immunocontraception could be a strong selective pressure, and that selecting for reproduction in individuals with poor immune response could lead to a general decline in immune function in populations where such evolution takes place. Other authors have also speculated that differences in antibody titer responses could be partially due to genetic differences between animals (Curtis et al. 2001, Herbert and Trigg 2005).

BLM is not aware of any studies that have quantified the heritability of a lack of response to immunocontraception such as PZP vaccine or GonaCon-Equine in horses. At this point there are no studies available from which one could make conclusions about the long-term effects of sustained and widespread immunocontraception treatments on population-wide immune function. Although a few, generally isolated, feral horse populations have been treated with high fractions of mares receiving PZP immunocontraception for long-term population control (e.g., Assateague Island and Pryor Mountains), no studies have tested for changes in immune competence in those areas. Relative to the large number of free-roaming feral horses in the western United States, immunocontraception has not been used in the type of widespread or prolonged manner that might be required to cause a detectable evolutionary response at a large scale.

Magiafolou et al. (2013) clarify that if the variation in immune response is due to environmental factors (i.e., body condition, social rank) and not due to genetic factors, then there will be no expected effect of the immune phenotype on future generations. Correlations between immune response and physical factors such as age and body condition have been documented; it remains untested whether or not those factors play a larger role in determining immune response to immunocontraceptives than heritable traits. Several studies discussed above noted a relationship between the strength of individuals' immune responses after treatment with GonaCon or other anti-GnRH vaccines, and factors related to body condition. For example, age at immunization was a primary factor associated with different measures of immune response, with young animals tending to have stronger and longer-lasting responses (Stout et al. 2003, Schulman et al. 2013). It is also possible that general health, as measured by body condition, can have a causal role in determining immune response, with animals in poor condition demonstrating poor immune reactions (Gray 2009, NRC 2013). Miller et al. (2013) speculated that animals with high parasite loads also may have weaker immune reactions to GonaCon.

Correlations between such physical factors and immune response would not preclude, though, that there could also be a heritable response to immunocontraception. In studies not directly related to immunocontraception, immune response has been shown to be heritable (Kean et al. 1994, Sarker et al. 1999). Unfortunately, predictions about the long-term, population-level evolutionary response to immunocontraceptive treatments would be speculative at this point, with results likely to depend on several factors, including: the strength of the genetic predisposition to not respond to GonaCon-Equine; the heritability of that gene or genes; the initial prevalence of that gene or genes; the number of mares treated with a primer dose of GonaCon-Equine (which generally has a short-acting effect, if any); the number of mares treated with a booster dose of GonaCon-Equine (which appears to cause a longer-lasting effect); and the actual size of the genetically-interacting metapopulation of horses within which the GonaCon treatment takes place.

Gelding

Castration (the surgical removal of the testicles, also called gelding or neutering) is a surgical procedure for the horse sterilization that has been used for millennia. The procedure is fairly straight forward, and has a relatively low complication rate. As noted in the review of scientific literature that follows, the expected effects of gelding are well understood overall, even though there is some degree of uncertainty about the exact quantitative outcomes for any given individual (as is true for any natural system). Reference in this text to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement, recommendation, or favoring by the Department of the Interior.

Including a portion of geldings in a herd can lead to a reduced population-level per-capita growth rate, by virtue of having fertile mares comprise a lower fraction of the herd. By having a skewed sex ratio with less females than males (stallions and geldings), the result will be that there will be a lower number of breeding females in the population. Including geldings in herd management is not new for BLM and federal land management. Geldings have been released on BLM lands as a part of herd management in the Barren Valley complex in Oregon (BLM 2011), the Challis HMA in Idaho (BLM 2012), and the Conger HMA in Utah (BLM 2016). Geldings were also included in US Fish and Wildlife Service management plans for the Sheldon National Wildlife Refuge that relied on sterilization and removals (Collins and Kasbohm 2016).

The more commonly applied methods for managing population growth of free-roaming wild horses focus largely on suppressing female fertility through contraceptive vaccines (e.g., Ballou et al. 2008, Killian et al. 2008, Turner et al. 2008, Gray et al. 2010, Ransom et al. 2011). Fewer studies have been conducted on techniques for reducing male fertility. Nelson (1980) and Garrott and Siniff (1992) modeled potential efficacy of male-oriented contraception as a population management tool, and both studies agreed that while slowing growth, sterilizing only dominant males (i.e., harem-holding stallions) would result in only marginal reduction in female fertility rates. Eagle et al. (1993) and Asa (1999) tested this hypothesis on herd management areas (HMAs) where dominant males were vasectomized. Their findings agreed with modeling results from previous studies, and they also concluded that sterilizing only dominant males would not provide the desired reduction in female fertility and overall population growth rate, assuming that the numbers of fertile females is not changed. While bands with vasectomized harem stallions tended to have fewer foals, breeding by bachelors and subordinate stallions meant that population growth still occurred – female fertility was not dramatically reduced. Garrott and Siniff (1992) concluded from their modeling that male sterilization would effectively cause there to be zero population growth (the point where births roughly equal deaths) only if a large proportion of males (i.e., >85%) could be sterilized. In cases where the goal of harem stallion sterilization is to reduce population growth rates, success appears to be dependent on a stable group structure, as strong bonds between a stallion and mares reduce the probability of a mare mating an extra-group stallion (Nelson 1980, Garrott and Siniff 1992, Eagle et al. 1993, Asa 1999). Collins and Kasbohm (2016) demonstrated that there was a reduced fertility rate in a feral horse herd with both spayed and vasectomized horses – some geldings were also present in that herd.

Despite these studies, geldings can be used to reduce overall growth rates in a management strategy that does not rely on any expectation that geldings will retain harems or lead to a reduction in per-female fertility rates. In alternatives being considered in this environmental analysis, the primary goal of including geldings in the herd is not necessarily to reduce female fertility. Rather, by including some geldings in a herd that also has fertile mares and stallions, the geldings would take some of the spaces toward AML that would otherwise be taken by fertile females. If the total number of horses is constant but geldings are included in the herd, this can reduce the number of fertile mares, therefore reducing the absolute number of foals produced. Put another way, if geldings occupy spaces toward AML that would otherwise be filled by fertile mares that will reduce growth rates merely by the fact of causing there to be a lower starting number of fertile mares.

Surgical sterilization techniques, while not reversible, may control horse reproduction without the kind of additional handling or darting that can be needed to administer contraceptive vaccines. In this sense, sterilization surgeries can be used to achieve herd management objectives with a relative minimum level of animal handling and management over the long term. The WFRHBA (as amended) indicates that management should be at the minimum level necessary to achieve management objectives (CFR 4710.4), and if gelding some fraction of a managed population can reduce population growth rates by replacing breeding mares, it then follows that gelding some individuals can lead to a reduced number of handling occasions and removals of excess horses from the range, which is consistent with legal guidelines. Other fertility control options that may be temporarily effective on male horses, such as the injection of GonaCon-Equine immunocontraceptive vaccine, apparently require multiple handling occasions to achieve longer-term male infertility. Similarly, PZP immunocontraception that is currently available for use in wild mares requires handling or darting every year. By some measures, any management activities that require multiple capture operations to treat a given individual would be more intrusive for wild horses and potentially less sustainable than an activity that requires only one handling occasion.

Gelding Direct Effects
Stallions between the ages of 6 months and 20 years, with a Henneke body condition score of 3 or higher (Henneke 1983) could be selected for gelding (see Appendix X). No animals which appear to be distressed, injured, or in poor health or condition would be selected for gelding. Stallions would not be gelded within 72 hours of capture. The surgery would be performed by a veterinarian using general anesthesia and appropriate surgical techniques. The final determination of which specific animals would be gelded would be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer (see Gelding SOPs in Appendix X). The final determination of which specific animals would be gelded would be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer.

When gelding procedures are done in the field, geldings would be released near a water source, when possible, approximately 24 to 48 hours following surgery. When the procedures are performed at a BLM-managed facility, selected stallions would be shipped to the facility, gelded, held in a separate pen to minimize risk for disease, and returned to the range within 30 days.

Though castration (gelding) is a common surgical procedure, some level of minor complications after surgery may be expected (Getman 2009), and it is not always possible to predict when postoperative complications would occur. Fortunately, the most common complications are almost always self-limiting, resolving with time and exercise. Individual impacts to the stallions during and following the gelding process should be minimal and would mostly involve localized swelling and bleeding. Complications may include, but are not limited to: minor bleeding, swelling, inflammation, edema, infection, peritonitis, hydrocele, penile damage, excessive hemorrhage, and eventration (Schumacher 1996, Searle et al. 1999, Getman 2009). A small amount of bleeding is normal and generally subsides quickly, within 2-4 hours following the procedure. Some degree of swelling is normal, including swelling of the prepuce and scrotum, usually peaking between 3-6 days after surgery (Searle et al. 1999). Swelling should be minimized through the daily movements (exercise) of the horse during travel to and from foraging and watering areas. Most cases of minor swelling should be back to normal within 5-7 days, more serious cases of moderate to severe swelling are also self-limiting and are expected to resolve with exercise after one to 2 weeks. Older horses are reported to be at greater risk of post-operative edema, but daily exercise can prevent premature closure of the incision, and prevent fluid buildup (Getman 2009). In some cases, a hydrocele (accumulation of sterile fluid) may develop over months or years (Searle et al. 1999). Serious complications (eventration, anesthetic reaction, injuries during handling, etc.) that result in euthanasia or mortality during and following surgery are rare (e.g., eventration rate of 0.2% to 2.6% noted in Getman 2009, but eventration rate of 4.8% noted in Shoemaker et al. 2004) and vary according to the population of horses being treated (Getman 2009). Normally one would expect serious complications in less than 5% of horses operated under general anesthesia, but in some populations these rates have been as high as 12% (Shoemaker 2004). Serious complications are generally noted within 3 or 4 hours of surgery but may occur any time within the first week following surgery (Searle et al. 1999). If they occur, they would be treated with surgical intervention when possible, or with euthanasia when there is a poor prognosis for recovery.

For intact stallions, testosterone levels appear to vary as a function of age, season, and harem size (Khalil et al 1998). It is expected that testosterone levels will decline over time after castration. Domestic geldings had a significant prolactin response to sexual stimulation, but lacked the cortisol response present in stallions (Colborn et al. 1991). Although libido and the ability to ejaculate tends to be gradually lost after castration (Thompson et al. 1980), some geldings continue to intromit (Rios and Houpt 1995, Schumacher 2006).

Effects of handling and marking

It is prudent for gelded animals to be readily identifiable, either via freeze brand marks or unique coloration, so that their treatment history is easily recognized (e.g., BLM 2010). Markings may also be useful into the future to determine the approximate fraction of geldings in a herd, and could provide additional insight regarding gather efficiency. BLM has instituted guidelines to reduce the sources of handling stress in captured animals (BLM 2015). Handling may include freeze-marking, for the purpose of identifying an individual. Some level of transient stress is likely to result in newly captured horses that are not previously marked. Under past management practices, captured horses experienced increased, transient stress levels from handling (Ashley and Holcombe 2001). It is difficult to compare that level of temporary stress with long-term stress that can result from food and water limitation on the range (e.g., Creel et al. 2013), which could occur in the absence of herd management.

Most horses recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from gelding, other than the direct

consequence of becoming infertile.
Selected stallions would be shipped to the facility, gelded, and returned to the range within 30 days. Gelded animals could be monitored periodically for complications for approximately 7-10 days following release. In the proposed alternatives, gelding is not part of any research study, but additional monitoring on the range could be completed either through aerial recon, if available, or field observations from major roads and trails. It is not anticipated that all the geldings would be observed but if the goal is to detect complications on the range, then this level of casual observation may help BLM determine if they are occurring. Observations of the long term outcomes of gelding could be recorded during routine resource monitoring work. Such observations could include but not be limited to band size, social interactions with other geldings and harem bands, distribution within their habitat, forage utilization and activities around key water sources. Periodic population inventories and future gather statistics could provide additional anecdotal information about how logistically effective it is to manage a portion of the herd as non-breeding animals.

Indirect Effects of Gelding
Castration is not expected to reduce geldings' survival rates. Castration is thought to increase survival as males are released from the cost of reproduction (Jewell 1997). In Soay sheep castrates survived longer than rams in the same cohort (Jewell 1997), and Misaki horse geldings lived longer than intact males (Kaseda et al. 1997, Khalil and Murakami 1999). Moreover, it is unlikely that a reduced testosterone level will compromise gelding survival in the wild, considering that wild mares survive with low levels of testosterone. Consistent with geldings not expending as much energy toward in attempts to obtain or defend a harem, it is expected that wild geldings may have a better body condition that wild, fertile stallions.
Under the proposed action, reproductive stallions would still be a component of the population's age and sex structure. The question of whether or not a given gelding would or would not attempt to maintain a harem is not germane to population-level management. Gelding a subset of stallions in the proposed action would not prevent other stallions and mares from continuing with the typical range of social behaviors for sexually active adults. For fertility control strategies where gelding is intended to reduce growth rates by virtue of sterile males defending harems, the National Academies of Sciences (NRC 2013) suggested that the effectiveness of gelding on overall reproductive rates may depend on the pre-castration social roles of those animals. However, in this decision the alternatives being considered that include gelding would reduce population growth rates by a different means: including geldings as a component of the total horses counted toward AML would effectively reduce the relative number of fertile mares in the herd. Having a post-gather herd with some geldings and a lower fraction of fertile mares necessarily reduces the absolute number of foals born per year, compared to a herd that includes more fertile mares. An additional benefit is that geldings that would otherwise be permanently removed from the range (for adoption, sale or other disposition) may be released back onto the range where they can engage in free-roaming behaviors.

BLM would expect that wild horse family structures will continue to exist under the proposed action within wild horse population, because fertile mares, stallions, and their foals will continue to be a component of the herd. Because the fraction of males gelded is not expected to come anywhere close to the ~85% threshold suggested by Garrott and Siniff (1992) as being necessary to substantially reduce population growth rates, is not expected that gelding a subset of stallions will significantly change the social structure or herd demographics (age and sex ratios) of fertile wild horses. It is worth noting, though, that the BLM is not required to manage populations of wild horses in a manner that ensures that any given individual maintains its social standing within any given harem or band.

Behavioral Effects of Gelding
Gelding adult male horses is expected to result in reduced testosterone production, which is expected to directly influence reproductive behaviors (NRC 2013). However, testosterone levels alone are not a predictor of masculine behavior (Line et al. 1985, Schumacher 2006). In domestic geldings, 20-30% continued to show stallion-like behavior, whether castrated pre- or post-puberty (Line et al. 1985). Gelding of domestic horses most commonly takes place before or shortly after sexual maturity, and age-at-gelding can affect the degree to which stallion-like behavior is expressed later in life. In intact stallions, testosterone levels peak increase up to an age of ~4-6 years, and can be higher in harem stallions than bachelors (Khalil et al 1998). It is assumed that free roaming wild horse geldings would generally exhibit reduced aggression toward other horses, and reduced reproductive behaviors (NRC 2013). The behavior of wild horse geldings in the presence of intact stallions has not been well documented, but the literature review below can be used to make reasonable inferences about their likely behaviors.

Despite livestock being managed by castrating males for millennia, there is relatively little published research on castrates' behaviors (Hart and Jones 1975). Stallion behaviors in wild or pasture settings are better documented than gelding behaviors, but it inferences about how the behaviors of geldings will change, how quickly any change will occur after surgery, or what effect gelding an adult stallion and releasing him back in to a wild horse population will have on his behavior and that of the wider population must be surmised from the existing literature. There is an ongoing BLM study in Utah focused on the individual and population-level effects of including some geldings in a free-roaming horse population (BLM 2016), but results from that study are not yet available. However, inferences about likely behavioral outcomes of gelding can be made based on available literature.
Feral horses typically form bands composed of an adult male with 1 to 3 adult females and their immature offspring (Feist and McCullough 1976, Berger 1986, Roelle et al. 2010). In many populations subordinate 'satellite' stallions have been observed associating with the band, although the function of these males continues to be debated (see Feh 1999, and Linklater and Cameron 2000). Juvenile offspring of both sexes leave the band at sexual maturity (normally around two or three years of age (Berger 1986), but adult females may remain with the same band over a span of years. Group stability and cohesion is maintained through positive social interactions and agonistic behaviors among all members, and herding and reproductive behaviors from the stallion (Ransom and Cade 2009). Group movements and consortship of a stallion with mares is advertised to other males through the group stallion marking dung piles as they are encountered, and over-marking mare eliminations as they occur (King and Gurnell 2006).

In horses, males play a variety of roles during their lives (Deniston 1979): after dispersal from their natal band they generally live as bachelors with other young males, before associating with mares and developing their own breeding group as a harem stallion or satellite stallion. In any population of horses not all males will achieve harem stallion status, so all males do not have an equal chance of breeding (Asa 1999). Stallion behavior is thought to be related to androgen levels, with breeding stallions having higher androgen concentrations than bachelors (Angle et al. 1979, Chaudhuri and Ginsberg 1990, Khalil et al. 1998). A bachelor with low libido had lower levels of androgens, and two year old bachelors had higher testosterone levels than two year olds with undescended testicles who remained with their natal band (Angle et al. 1979).

The effect of castration on aggression in horses has not often been quantified. One report has noted that high levels of aggression continued to be observed in domestic horse geldings who also exhibited sexual behaviors (Rios and Houpt 1995). Stallion-like behavior in domestic horse geldings is relatively common (Smith 1974, Schumacher 1996), being shown in 20-33% of cases whether the horse was castrated pre- or post-puberty (Line et al. 1985, Rios and Houpt 1995, Schumacher 2006). While some of these cases may be due to cryptorchidism or incomplete surgery, it appears that horses are less dependent on hormones than other mechanisms for the maintenance of sexual behaviors (Smith 1974). Domestic geldings exhibiting masculine behavior had no difference in testosterone concentrations than other geldings (Line et al. 1985, Schumacher 2006), and in some instances the behavior appeared context dependent (Borsberry 1980, Pearce 1980).
Dogs and cats are commonly neutered, and it is also common for them to continue to exhibit reproductive behaviors several years after castration (Dunbar 1975). Dogs, ferrets, hamsters, and marmosets continued to show sexually motivated behaviors after castration, regardless of whether they had previous experience or not, although in beagles and ferrets there was a reduction in motivation post-operatively (Hart 1968, Dunbar 1975, Dixson 1993, Costantini et al. 2007, Vinke et al. 2008). Ungulates continued to show reproductive behaviors after castration, with goats and llamas continuing to respond to females even a year later in the case of goats, although mating time and the ejaculatory response was reduced (Hart and Jones 1975, Nickolmann et al. 2008).

The likely effects of castration on geldings' social interactions and group membership can be inferred from available literature, even though wild horses are rarely gelded and released back into the wild, resulting in few studies that have investigated their behavior in free-roaming populations. In the western US – where ranges are much larger, intact stallions are present year-round, and population density varies – free-roaming gelding behaviors may differ somewhat from those noted below. In a pasture study of domestic horses, Van Dierendonk et al. (1995) found that social rank among geldings was directly correlated to the age at which the horse was castrated, suggesting that social experiences prior to sterilization may influence behavior afterward. Of the two geldings present in a study of semi-feral horses in England, one was dominant over the mares whereas a younger gelding was subordinate to older mares; stallions were only present in this population during a short breeding season (Tyler 1972). A study of domestic geldings in Iceland held in a large pasture with mares and sub-adults of both sexes, but no mature stallions, found that geldings and sub-adults formed associations amongst each other that included interactions such as allo-grooming and play, and were defined by close proximity (Sigurjónsdóttir et al. 2003). These geldings and sub-adults tended to remain in a separate group from mares with foals, similar to castrated Soay sheep rams (*Ovis aries*) behaving like bachelors and grouping together, or remaining in their mother's group (Jewell 1997). In Japan, Kaseda et al. (1997) reported that young males dispersing from their natal harem and geldings moved to a different area than stallions and mares during the non-breeding season. Although the situation in Japan may be the equivalent of a bachelor group in natural populations, in Iceland this division between mares and the rest of the horses in the herd contradicts the dynamics typically observed in a population containing mature stallions. Sigurjónsdóttir et al. (2003) also noted that in the absence of a stallion, allo-grooming between adult females increased drastically. Other findings included increased social interaction among yearlings, display of stallion-like behaviors such as mounting by the adult females, and decreased association between females and their yearling offspring (Sigurjónsdóttir et al. 2003). In the same population in Iceland Van Dierendonck et al. (2004) concluded that the presence of geldings did not appear to affect the social behavior of mares or negatively influence parturition, mare-foal bonding, or subsequent maternal activities. Additionally, the welfare of broodmares and their foals was not affected by the presence of geldings in the herd (Van Dierendonck et al. 2004). These findings are important because treated geldings will be returned to the range in the presence of pregnant mares and mares with foals of the year.

The likely effects of castration on geldings' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). By comparison, bachelor groups tend to be more transient, and can potentially use areas of good forage further from water sources, as they are not constrained by the needs of lactating mares in a group. The number of observations of gelded wild stallion behavior are still too few to make general predictions about whether a particular gelded stallion individuals will behave like a harem stallion, a bachelor, or form a group with geldings that may forage and water differently from fertile wild horses.

Gelding wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether geldings will continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that geldings would continue to roam unhindered in the HMA(s) / Complex (es) where this action would take place. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a gelded animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that gelding wild horses will cause them to lose their free-roaming nature. It is worth noting that individual choices in wild horse group membership, home range, and habitat use are not protected under the WFRHBA. BLM acknowledges that geldings may exhibit some behavioral differences after surgery, compared to intact stallions, but those differences are not be expected to remove the geldings' rebellious and feisty nature, or their defiance of man. While it may be that a gelded horse could have a different set of behavioral priorities than an intact stallion, the expectation is that geldings will choose to act upon their behavioral priorities in an unhindered way, just as is the case for an intact stallion. In this sense, a gelded male would be just as much 'wild' as defined by the WFRHBA as any intact stallion, even if his patterns of movement differ from those of an intact stallion. Congress specified that sterilization is an acceptable management action (16 USC §1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC §1333.2.C.d). Several academics have offered their opinions about whether gelding a given stallion would lead to that individual effectively losing its status as a wild horse (Rutberg 2011, Kirkpatrick 2012, Nock 2017). Those opinions are based on a semantic and subjective definition of 'wild,' while BLM must adhere to the legal definition of what constitutes a wild horse, based on the WFRHBA (as amended). Those individuals have not conducted any studies that would test the speculative opinion that gelding wild stallions will cause them to become docile. BLM is not obliged to base management decisions on such opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Genetic Effects of Gelding

It is true that geldings are unable to contribute to the genetic diversity of the herd, but that does not lead to an expectation that the HMA(s) / Complexes would necessarily experience high levels of inbreeding, because there would be a core breeding population of stallions consistent with low end AML. Existing levels of genetic diversity were high in this area when last measured, and expectations are that heterozygosity levels are even higher now, because the population has continued to grow exponentially in the recent past. In addition, many of the stallions that would be gelded would have already had a chance to breed, passing on genetic material to their offspring. BLM is not obligated to ensure that any given individual in a herd has the chance to sire a foal and pass on genetic material. The herd in which the proposed action is to take place are not at immediate or future risk of catastrophic loss of genetic diversity, nor does the genetic diversity in this herd represent unique genetic information. This action does not prevent BLM from augmenting genetic diversity in the treated herd in the future, if future genetic monitoring indicates that would be necessary.

It is not expected that genetic health would be affected by the Proposed Action. Available indications are that these populations contain high levels of genetic diversity at this time. More information about the genetic diversity in these populations will become available as a result of genetic monitoring under Alternatives 2 or 3. If at any time in the future the genetic diversity in either HMA is determined to be relatively low, then a large number of other HMAs could be used as sources for fertile wild horses that could be translocated into the HMA of concern (BLM 2010).

The HMA(s)/ complex is/ are located such that a small number of horses can enter the population from neighboring areas (adjacent HMAs). As such, there is the potential for some additional genetic information to continually enter this population. The BLM allows for the possibility that, if future genetic testing indicates that there is a critically low genetic diversity in the HMA(s) / Complexes herd and other herds that interact with it genetically, future management of the HMA(s) / Complexes herd could include genetic augmentation, by bringing in additional stallions, mares, or both. The NRC report (2013) recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010).

Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Although those results are specific to mares, some inferences about potential effects of stallion sterilization may be made from their results. Roelle and Oyler-McCance (2015) showed that the risk of the loss of genetic heterozygosity is extremely low except in cases where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the population are permanently sterilized.

BLM acknowledges that if the management goal was to sterilize >85% of males in a population, that could lead to genetic consequences of reduced heterozygosity and increased inbreeding coefficients, as it would potentially allow a very small group of males to dominate the breeding (e.g., Saltz et al. 2000). Such genetic consequences could be mitigated by natural movements or human-facilitated translocations (BLM 2010). However, the question of how >85% gelded males in a population would interact with intact stallions and mares and with their habitat is not relevant to this decision because that level of castration is not being considered as an alternative in this decision. Garrott and Siniff's (1992) model predicts that gelding 50-80% of mature males in the population would result in reduced, but not halted, mare fertility rates. However, within a few years after any male sterilization treatment, a number of fertile male colts would become sexually mature stallions who could contribute genetically to the herd.

Gelding Review, 25 May 2018, Dr. Paul Griffin

Castration (the surgical removal of the testicles, also called gelding or neutering) is a surgical procedure for the horse sterilization that has been used for millennia. The procedure is fairly straight forward, and has a relatively low complication rate. As noted in the review of scientific literature that follows, the expected effects of gelding are well understood overall, even though there is some degree of uncertainty about the exact quantitative outcomes for any given individual (as is true for any natural system). Reference in this text to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement, recommendation, or favoring by the Department of the Interior.

Including a portion of geldings in a herd can lead to a reduced population-level per-capita growth rate, by virtue of having fertile mares comprise a lower fraction of the herd. By having a skewed sex ratio with less females than males (stallions and geldings), the result will be that there will be a lower number of breeding females in the population. Including geldings in herd management is not new for BLM and federal land management. Geldings have been released on BLM lands as a part of herd management in the Barren Valley complex in Oregon (BLM 2011), the Challis HMA in Idaho (BLM 2012), and the Conger HMA in Utah (BLM 2016). Geldings were also included in US Fish and Wildlife Service management plans for the Sheldon National Wildlife Refuge that relied on sterilization and removals (Collins and Kasbohm 2016).

The more commonly applied methods for managing population growth of free-roaming wild horses focus largely on suppressing female fertility through contraceptive vaccines (e.g., Ballou et al. 2008, Killian et al. 2008, Turner et al. 2008, Gray et al. 2010, Ransom et al. 2011). Fewer studies have been conducted on techniques for reducing male fertility. Nelson (1980) and Garrott and Siniff (1992) modeled potential efficacy of male-oriented contraception as a population management tool, and both studies agreed that while slowing growth, sterilizing only dominant males (i.e., harem-holding stallions) would result in only marginal reduction in female fertility rates. Eagle et al. (1993) and Asa (1999) tested this hypothesis on herd management areas (HMAs) where dominant males were vasectomized. Their findings agreed with modeling results from previous studies, and they also concluded that sterilizing only dominant males would not provide the desired reduction in female fertility and overall population growth rate, assuming that the numbers of fertile females is not changed. While bands with vasectomized harem stallions tended to have fewer foals, breeding by bachelors and subordinate stallions meant that population growth still occurred – female fertility was not dramatically reduced. Garrott and Siniff (1992) concluded from their modeling that male sterilization would effectively cause there to be zero population growth (the point where births roughly equal deaths) only if a large proportion of males (i.e., >85%) could be sterilized. In cases where the goal of harem stallion sterilization is to reduce population growth rates, success appears to be dependent on a stable group structure, as strong bonds between a stallion and mares reduce the probability of a mare mating an extra-group stallion (Nelson 1980, Garrott and Siniff 1992, Eagle et al. 1993, Asa 1999). Collins and Kasbohm (2016) demonstrated that there was a reduced fertility rate in a feral horse herd with both spayed and vasectomized horses – some geldings were also present in that herd.

Despite these studies, geldings can be used to reduce overall growth rates in a management strategy that does not rely on any expectation that geldings will retain harems or lead to a reduction in per-female fertility rates. In alternatives being considered in this environmental analysis, the primary goal of including geldings in the herd is not necessarily to reduce female fertility. Rather, by including some geldings in a herd that also has fertile mares and stallions, the geldings would take some of the spaces toward AML that would otherwise be taken by fertile females. If the total number of horses is constant but geldings are included in the herd, this can reduce the number of fertile mares, therefore reducing the absolute number of foals produced. Put another way, if geldings occupy spaces toward AML that would otherwise be filled by fertile mares that will reduce growth rates merely by the fact of causing there to be a lower starting number of fertile mares.

Surgical sterilization techniques, while not reversible, may control horse reproduction without the kind of additional handling or darting that can be needed to administer contraceptive vaccines. In this sense, sterilization surgeries can be used to achieve herd management objectives with a relative minimum level of animal handling and management over the long term. The WFRHBA (as amended) indicates that management should be at the minimum level necessary to achieve management objectives (CFR 4710.4), and if gelding some fraction of a managed population can reduce population growth rates by replacing breeding mares, it then follows that gelding some individuals can lead to a reduced number of handling occasions and removals of excess horses from the range, which is consistent with legal guidelines. Other fertility control options that may be temporarily effective on male horses, such as the injection of GonaCon-Equine immunocontraceptive vaccine, apparently require multiple handling occasions to achieve longer-term male infertility. Similarly, PZP immunocontraception that is currently available for use in wild mares requires handling or darting every year. By some measures, any management activities that require multiple capture operations to treat a given individual would be more intrusive for wild horses and potentially less sustainable than an activity that requires only one handling occasion.

Gelding Direct Effects

Stallions between the ages of 6 months and 20 years, with a Henneke body condition score of 3 or higher (Henneke 1983) could be selected for gelding (see Appendix X). No animals which appear to be distressed, injured, or in poor health or condition would be selected for gelding. Stallions would not be gelded within 72 hours of capture. The surgery would be performed by a veterinarian using general anesthesia and appropriate surgical techniques. The final determination of which specific animals would be gelded would be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer (see Gelding SOPs in Appendix X). The final determination of which specific animals would be gelded would be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer.

When gelding procedures are done in the field, geldings would be released near a water source, when possible, approximately 24 to 48 hours following surgery. When the procedures are performed at a BLM-managed facility, selected stallions would be shipped to the facility, gelded, held in a separate pen to minimize risk for disease, and returned to the range within 30 days.

Though castration (gelding) is a common surgical procedure, some level of minor complications after surgery may be expected (Getman 2009), and it is not always possible to predict when postoperative complications would occur. Fortunately, the most common complications are almost always self-limiting, resolving with time and exercise. Individual impacts to the stallions during and following the gelding process should be minimal and would mostly involve localized swelling and bleeding. Complications may include, but are not limited to: minor bleeding, swelling, inflammation, edema, infection, peritonitis, hydrocele, penile damage, excessive hemorrhage, and eventration (Schumacher 1996, Searle et al. 1999, Getman 2009). A small amount of bleeding is normal and generally subsides quickly, within 2-4 hours following the procedure. Some degree of swelling is normal, including swelling of the prepuce and scrotum, usually peaking between 3-6 days after surgery (Searle et al. 1999). Swelling should be minimized through the daily movements (exercise) of the horse during travel to and from foraging and watering areas. Most cases of minor swelling should be back to normal within 5-7 days, more serious cases of moderate to severe swelling are also self-limiting and are expected to resolve with exercise after one to 2 weeks. Older horses are reported to be at greater risk of post-operative edema, but daily exercise can prevent premature closure of the incision, and prevent fluid buildup (Getman 2009). In some cases, a hydrocele (accumulation of sterile fluid) may develop over months or years (Searle et al. 1999). Serious complications (eventration, anesthetic reaction, injuries during handling, etc.) that result in euthanasia or mortality during and following surgery are rare (e.g., eventration rate of 0.2% to 2.6% noted in Getman 2009, but eventration rate of 4.8% noted in Shoemaker et al. 2004) and vary according to the population of horses being treated (Getman 2009). Normally one would expect serious complications in less than 5% of horses operated under general anesthesia, but in some populations these rates have been as high as 12% (Shoemaker 2004). Serious complications are generally noted within 3 or 4 hours of surgery but may occur any time within the first week following surgery (Searle et al. 1999). If they occur, they would be treated with surgical intervention when possible, or with euthanasia when there is a poor prognosis for recovery.

For intact stallions, testosterone levels appear to vary as a function of age, season, and harem size (Khalil et al 1998). It is expected that testosterone levels will decline over time after castration. Domestic geldings had a significant prolactin response to sexual stimulation, but lacked the cortisol response present in stallions (Colborn et al. 1991). Although libido and the ability to ejaculate tends to be gradually lost after castration (Thompson et al. 1980), some geldings continue to intromit (Rios and Houpt 1995, Schumacher 2006).

Effects of handling and marking

It is prudent for gelded animals to be readily identifiable, either via freeze brand marks or unique coloration, so that their treatment history is easily recognized (e.g., BLM 2010). Markings may also be useful into the future to determine the approximate fraction of geldings in a herd, and could provide additional insight regarding gather efficiency. BLM has instituted guidelines to reduce the sources of handling stress in captured animals (BLM 2015). Handling may include freeze-marking, for the purpose of identifying an individual. Some level of transient stress is likely to result in newly captured horses that are not previously marked. Under past management practices, captured horses experienced increased, transient stress levels from handling (Ashley and Holcombe 2001). It is difficult to compare that level of temporary stress with long-term stress that can result from food and water limitation on the range (e.g., Creel et al. 2013), which could occur in the absence of herd management.

Most horses recover from the stress of capture and handling quickly once released back to the HMA, and none are expected to suffer serious long term effects from gelding, other than the direct consequence of becoming infertile.

Selected stallions would be shipped to the facility, gelded, and returned to the range within 30 days. Gelded animals could be monitored periodically for complications for approximately 7-10 days following release. In the proposed alternatives, gelding is not part of any research study, but additional monitoring on the range could be completed either through aerial recon, if available, or field observations from major roads and trails. It is not anticipated that all the geldings would be observed but if the goal is to detect complications on the range, then this level of casual observation may help BLM determine if they are occurring. Observations of the long term outcomes of gelding could be recorded during routine resource monitoring work. Such observations could include but not be limited to band size, social interactions with other geldings and harem bands, distribution within their habitat, forage utilization and activities around key water sources. Periodic population inventories and future gather statistics could provide additional anecdotal information about how logistically effective it is to manage a portion of the herd as non-breeding animals.

Indirect Effects of Gelding

Castration is not expected to reduce geldings' survival rates. Castration is thought to increase survival as males are released from the cost of reproduction (Jewell 1997). In Soay sheep castrates survived longer than rams in the same cohort (Jewell 1997), and Misaki horse geldings lived longer than intact males (Kaseda et al. 1997, Khalil and Murakami 1999). Moreover, it is unlikely that a reduced testosterone level will compromise gelding survival in the wild, considering that wild mares survive with low levels of testosterone. Consistent with geldings not expending as much energy toward in attempts to obtain or defend a harem, it is expected that wild geldings may have a better body condition that wild, fertile stallions.

Under the proposed action, reproductive stallions would still be a component of the population's age and sex structure. The question of whether or not a given gelding would or would not attempt to maintain a harem is not germane to population-level management. Gelding a subset of stallions in the proposed action would not prevent other stallions and mares from continuing with the typical range of social behaviors for sexually active adults. For fertility control strategies where gelding is intended to reduce growth rates by virtue of sterile males defending harems, the National Academies of Sciences (NRC 2013) suggested that the effectiveness of gelding on overall reproductive rates may depend on the pre-castration social roles of those animals. However, in this decision the alternatives being considered that include gelding would reduce population growth rates by a different means: including geldings as a component of the total horses counted toward AML would effectively reduce the relative number of fertile mares in the herd. Having a post-gather herd with some geldings and a lower fraction of fertile mares necessarily reduces the absolute number of foals born per year, compared to a herd that includes more fertile mares. An additional benefit is that geldings that would otherwise be permanently removed from the range (for adoption, sale or other disposition) may be released back onto the range where they can engage in free-roaming behaviors.

BLM would expect that wild horse family structures will continue to exist under the proposed action within wild horse population, because fertile mares, stallions, and their foals will continue to be a component of the herd. Because the fraction of males gelded is not expected to come anywhere close to the ~85% threshold suggested by Garrott and Siniff (1992) as being necessary to substantially reduce population growth rates, is not expected that gelding a subset of stallions will significantly change the social structure or herd demographics (age and sex ratios) of fertile wild horses. It is worth noting, though, that the BLM is not required to manage populations of wild horses in a manner that ensures that any given individual maintains its social standing within any given harem or band.

Behavioral Effects of Gelding

Gelding adult male horses is expected to result in reduced testosterone production, which is expected to directly influence reproductive behaviors (NRC 2013). However, testosterone levels alone are not a predictor of masculine behavior (Line et al. 1985, Schumacher 2006). In domestic geldings, 20-30% continued to show stallion-like behavior, whether castrated pre- or post-puberty (Line et al. 1985). Gelding of domestic horses most commonly takes place before or shortly after sexual maturity, and age-at-gelding can affect the degree to which stallion-like behavior is expressed later in life. In intact stallions, testosterone levels peak increase up to an age of ~4-6 years, and can be higher in harem stallions than bachelors (Khalil et al 1998). It is assumed that free roaming wild horse geldings would generally exhibit reduced aggression toward other horses, and reduced reproductive behaviors (NRC 2013). The behavior of wild horse geldings in the presence of intact stallions has not been well documented, but the literature review below can be used to make reasonable inferences about their likely behaviors.

Despite livestock being managed by castrating males for millennia, there is relatively little published research on castrates' behaviors (Hart and Jones 1975). Stallion behaviors in wild or pasture settings are better documented than gelding behaviors, but it inferences about how the behaviors of geldings will change, how quickly any change will occur after surgery, or what effect gelding an adult stallion and releasing him back in to a wild horse population will have on his behavior and that of the wider population must be surmised from the existing literature. There is an ongoing BLM study in Utah focused on the individual and population-level effects of including some geldings in a free-roaming horse population (BLM 2016), but results from that study are not yet available. However, inferences about likely behavioral outcomes of gelding can be made based on available literature.
Feral horses typically form bands composed of an adult male with 1 to 3 adult females and their immature offspring (Feist and McCullough 1976, Berger 1986, Roelle et al. 2010). In many populations subordinate 'satellite' stallions have been observed associating with the band, although the function of these males continues to be debated (see Feh 1999, and Linklater and Cameron 2000). Juvenile offspring of both sexes leave the band at sexual maturity (normally around two or three years of age (Berger 1986), but adult females may remain with the same band over a span of years. Group stability and cohesion is maintained through positive social interactions and agonistic behaviors among all members, and herding and reproductive behaviors from the stallion (Ransom and Cade 2009). Group movements and consortship of a stallion with mares is advertised to other males through the group stallion marking dung piles as they are encountered, and over-marking mare eliminations as they occur (King and Gurnell 2006).

In horses, males play a variety of roles during their lives (Deniston 1979): after dispersal from their natal band they generally live as bachelors with other young males, before associating with mares and developing their own breeding group as a harem stallion or satellite stallion. In any population of horses not all males will achieve harem stallion status, so all males do not have an equal chance of breeding (Asa 1999). Stallion behavior is thought to be related to androgen levels, with breeding stallions having higher androgen concentrations than bachelors (Angle et al. 1979, Chaudhuri and Ginsberg 1990, Khalil et al. 1998). A bachelor with low libido had lower levels of androgens, and two year old bachelors had higher testosterone levels than two year olds with undescended testicles who remained with their natal band (Angle et al. 1979).

The effect of castration on aggression in horses has not often been quantified. One report has noted that high levels of aggression continued to be observed in domestic horse geldings who also exhibited sexual behaviors (Rios and Houpt 1995). Stallion-like behavior in domestic horse geldings is relatively common (Smith 1974, Schumacher 1996), being shown in 20-33% of cases whether the horse was castrated pre- or post-puberty (Line et al. 1985, Rios and Houpt 1995,

Schumacher 2006). While some of these cases may be due to cryptorchidism or incomplete surgery, it appears that horses are less dependent on hormones than other mechanisms for the maintenance of sexual behaviors (Smith 1974). Domestic geldings exhibiting masculine behavior had no difference in testosterone concentrations than other geldings (Line et al. 1985, Schumacher 2006), and in some instances the behavior appeared context dependent (Borsberry 1980, Pearce 1980).
Dogs and cats are commonly neutered, and it is also common for them to continue to exhibit reproductive behaviors several years after castration (Dunbar 1975). Dogs, ferrets, hamsters, and marmosets continued to show sexually motivated behaviors after castration, regardless of whether they had previous experience or not, although in beagles and ferrets there was a reduction in motivation post-operatively (Hart 1968, Dunbar 1975, Dixson 1993, Costantini et al. 2007, Vinke et al. 2008). Ungulates continued to show reproductive behaviors after castration, with goats and llamas continuing to respond to females even a year later in the case of goats, although mating time and the ejaculatory response was reduced (Hart and Jones 1975, Nickolmann et al. 2008).

The likely effects of castration on geldings' social interactions and group membership can be inferred from available literature, even though wild horses are rarely gelded and released back into the wild, resulting in few studies that have investigated their behavior in free-roaming populations. In the western US – where ranges are much larger, intact stallions are present year-round, and population density varies – free-roaming gelding behaviors may differ somewhat from those noted below. In a pasture study of domestic horses, Van Dierendonk et al. (1995) found that social rank among geldings was directly correlated to the age at which the horse was castrated, suggesting that social experiences prior to sterilization may influence behavior afterward. Of the two geldings present in a study of semi-feral horses in England, one was dominant over the mares whereas a younger gelding was subordinate to older mares; stallions were only present in this population during a short breeding season (Tyler 1972). A study of domestic geldings in Iceland held in a large pasture with mares and sub-adults of both sexes, but no mature stallions, found that geldings and sub-adults formed associations amongst each other that included interactions such as allo-grooming and play, and were defined by close proximity (Sigurjónsdóttir et al. 2003). These geldings and sub-adults tended to remain in a separate group from mares with foals, similar to castrated Soay sheep rams (*Ovis aries*) behaving like bachelors and grouping together, or remaining in their mother's group (Jewell 1997). In Japan, Kaseda et al. (1997) reported that young males dispersing from their natal harem and geldings moved to a different area than stallions and mares during the non-breeding season. Although the situation in Japan may be the equivalent of a bachelor group in natural populations, in Iceland this division between mares and the rest of the horses in the herd contradicts the dynamics typically observed in a population containing mature stallions. Sigurjónsdóttir et al. (2003) also noted that in the absence of a stallion, allo-grooming between adult females increased drastically. Other findings included increased social interaction among yearlings, display of stallion-like behaviors such as mounting by the adult females, and decreased association between females and their yearling offspring (Sigurjónsdóttir et al. 2003). In the same population in Iceland Van Dierendonck et al. (2004) concluded that the presence of geldings did not appear to affect the social behavior of mares or negatively influence parturition, mare-foal bonding, or subsequent maternal activities. Additionally, the welfare of broodmares and their foals was not affected by the presence of geldings in the herd (Van Dierendonck et al. 2004). These findings are important because treated geldings will be returned to the range in the presence of pregnant mares and mares with foals of the year.

The likely effects of castration on geldings' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). By comparison, bachelor groups tend to be more transient, and can potentially use areas of good forage further from water sources, as they are not constrained by the needs of lactating mares in a group. The number of observations of gelded wild stallion behavior are still too few to make general predictions about whether a particular gelded stallion individuals will behave like a harem stallion, a bachelor, or form a group with geldings that may forage and water differently from fertile wild horses.

Gelding wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether geldings will continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that geldings would continue to roam unhindered in the HMA(s) / Complex (es) where this action would take place. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a gelded animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that gelding wild horses will cause them to lose their free-roaming nature. It is worth noting that individual choices in wild horse group membership, home range, and habitat use are not protected under the WFRHBA. BLM acknowledges that geldings may exhibit some behavioral differences after surgery, compared to intact stallions, but those differences are not be expected to remove the geldings' rebellious and feisty nature, or their defiance of man. While it may be that a gelded horse could have a different set of behavioral priorities than an intact stallion, the expectation is that geldings will choose to act upon their behavioral priorities in an unhindered way, just as is the case for an intact stallion. In this sense, a gelded male would be just as much 'wild' as defined by the WFRHBA as any intact stallion, even if his patterns of movement differ from those of an intact stallion. Congress specified that sterilization is an acceptable management action (16 USC §1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC §1333.2.C.d). Several academics have offered their opinions about whether gelding a given stallion would lead to that individual effectively losing its status as a wild horse (Rutberg 2011, Kirkpatrick 2012, Nock 2017). Those opinions are based on a semantic and subjective definition of 'wild,' while BLM must adhere to the legal definition of what constitutes a wild horse, based on the WFRHBA (as amended). Those individuals have not conducted any studies that would test the speculative opinion that gelding wild stallions will cause them to become docile. BLM is not obliged to base management decisions on such opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Genetic Effects of Gelding
It is true that geldings are unable to contribute to the genetic diversity of the herd, but that does not lead to an expectation that the HMA(s) / Complexes would necessarily experience high levels of inbreeding, because there would be a core breeding population of stallions consistent with low end AML. In addition, many of the stallions that would be gelded would have already had a chance to breed, passing on genetic material to their offspring. BLM is not obligated to ensure that any given individual in a herd has the chance to sire a foal and pass on genetic material. The herd in which the proposed action is to take place are not at immediate or future risk of catastrophic loss of genetic diversity, nor does the genetic diversity in this herd represent unique genetic information. This

action does not prevent BLM from augmenting genetic diversity in the treated herd in the future, if future genetic monitoring indicates that would be necessary.

It is not expected that genetic health would be affected by the Proposed Action. More information about the genetic diversity in these populations will become available as a result of genetic monitoring under Alternatives 2 or 3. If at any time in the future the genetic diversity in either HMA is determined to be relatively low, then a large number of other HMAs could be used as sources for fertile wild horses that could be translocated into the HMA of concern (BLM 2010).

The #### HMA(s)/ complex is/ are located such that a small number of horses can enter the population from neighboring areas (adjacent HMAs). As such, there is the potential for some additional genetic information to continually enter this population. The BLM allows for the possibility that, if future genetic testing indicates that there is a critically low genetic diversity in the HMA(s) / Complexes herd and other herds that interact with it genetically, future management of the HMA(s) / Complexes herd could include genetic augmentation, by bringing in additional stallions, mares, or both. The NRC report (2013) recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010).

Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Although those results are specific to mares, some inferences about potential effects of stallion sterilization may be made from their results. Roelle and Oyler-McCance (2015) showed that the risk of the loss of genetic heterozygosity is extremely low except in cases where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the population are permanently sterilized.

BLM acknowledges that if the management goal was to sterilize >85% of males in a population, that could lead to genetic consequences of reduced heterozygosity and increased inbreeding coefficients, as it would potentially allow a very small group of males to dominate the breeding (e.g., Saltz et al. 2000). Such genetic consequences could be mitigated by natural movements or human-facilitated translocations (BLM 2010). However, the question of how >85% gelded males in a population would interact with intact stallions and mares and with their habitat is not relevant to this decision because that level of castration is not being considered as an alternative in this decision. Garrott and Siniff's (1992) model predicts that gelding 50-80% of mature males in the population would result in reduced, but not halted, mare fertility rates. However, within a few years after any male sterilization treatment, a number of fertile male colts would become sexually mature stallions who could contribute genetically to the herd.

Literature Review on Effects of Ovariectomy (Spaying), Wild Horses

11 June 2108, Dr. Paul Griffin

<u>*Current Methods*</u>
This literature review of spay impacts focuses on 2 methods: flank laparoscopy, and colpotomy. The anticipated effects of the spay treatment are both physical and behavioral. Physical effects would be due to post-surgical healing and the possibility for complications.

Ovariectomy via Colpotomy Procedure
Colpotomy is a surgical techniques in which there is no external incision, reducing susceptibility to infection. Ovariectomy via colpotomy is a relatively short surgery, with a relatively quick expected recovery time. In 1903, Williams first described a vaginal approach, or colpotomy, using an ecraseur to ovariectomize mares (Loesch and Rodgerson 2003). The ovariectomy via colpotomy procedure has been conducted for over 100 years, normally on open (non-pregnant), domestic mares. It is expected that the surgeon should be able to access ovaries with ease in mares that are in the early- or mid-stage of pregnancy. The anticipated risks associated with the pregnancy are described below. When wild horses are gathered or trapped for fertility control treatment there would likely be mares in various stages of gestation. Removal of the ovaries is permanent and 100 percent effective, however the procedure is not without risk. The proposed alternative would allow for researchers to quantify the outcomes of using ovariectomy via colpotomy for mares that are in various gestational stages. The proposed alternative would also allow researchers to record in detail and test for any behavioral effects on the range.

Ovariectomy via Flank Laparoscopy Procedure
Flank laparoscopy (Lee and Hendrickson 2008) is commonly used in domestic horses for application in mares due to its minimal invasiveness and full observation of the operative field. Ovariectomy via flank laparoscopy was seen as the lowest risk method considered by a panel of expert reviewers convened by USGS (Bowen 2015). In a review of unilateral and bilateral laparoscopic ovariectomy on 157 mares, Röcken et al. (2011) found that 10.8% of mares had minor post-surgical complications, and recorded no mortality. Mortality due to this type of surgery, or post-surgical complications, is not expected, but is a possibility. In two studies, ovariectomy by laparoscopy or endoscope-assisted colpotomy did not cause mares to lose weight, and there was no need for rescue analgesia following surgery (Pader et al. 2011, Bertin et al. 2013). This surgical approach entails three small incisions on the animal's flank, through which three cannulae (tubes) allow entry of narrow devices to enter the body cavity: these are the insufflator, endoscope, and surgical instrument. The surgical procedure involves the use of narrow instruments introduced into the abdomen via cannulas for the purpose of transecting the ovarian pedicle, but the insufflation should allow the veterinarian to navigate inside the abdomen without damaging other internal organs. The insufflator blows air into the cavity to increase the operating space between organs, and the endoscope provides a video feed to visualize the operation of the surgical instrument. This procedure can require a relatively long duration of surgery, but tends to lead to the lowest post-operative rates of complications. Flank laparoscopy may leave three small (<5 cm) visible scars on one side of the horse's flank, but even in performance horses these scars are considered minimal. It is expected that the tissues and musculature under the skin at the site of the incisions in the flank will heal quickly, leaving no long-lasting effects on horse health. Monitoring for up to two weeks at the facility where surgeries take place will allow for veterinary inspection of wound healing. The ovaries may be dropped into the abdomen, but this is not expected to cause any health problem; it is usually done in ovariectomies in cattle (e.g., the Willis Dropped Ovary Technique) and Shoemaker

et al. (2014) found no problems with revascularization or necrosis in a study of young horses using this method.

Anticipated Effects of Surgery on a Pregnancy

The average mare gestation period ranges from 335 to 340 days (Evans et al. 1977, p. 373). There are few peer reviewed studies documenting the effects of ovariectomy on the success of pregnancy in a mare. A National Research Council (NRC) committee that reviewed research proposals in 2015 explained, “The mare’s ovaries and their production of progesterone are required during the first 70 days of pregnancy to maintain the pregnancy” (NRC 2015). In female mammals, less progesterone is produced when ovaries are removed, but production does not cease (Webley and Johnson 1982). In 1977, Evans et al. stated that by 200 days, the secretion of progesterone by the corpora lutea is insignificant because removal of the ovaries does not result in abortion (p. 376). “If this procedure were performed in the first 120 days of pregnancy, the fetus would be resorbed or aborted by the mother. If performed after 120 days, the pregnancy should be maintained. The effect of ovary removal on a pregnancy at 90–120 days of gestation is unpredictable because it is during this stage of gestation that the transition from corpus luteum to placental support typically occurs” (NRC Proposal Review 2015). In 1979, Holtan et al. evaluated the effects of bilateral ovariectomy at selected times between 25 and 210 days of gestation on 50 mature pony mares. Their results show that abortion (resorption) of the conceptus (fetus) occurred in all 14 mares ovariectomized before day 50 of gestation, that pregnancy was maintained in 11 of 20 mares after ovariectomy between days 50 and 70, and that pregnancy was not interrupted in any of 12 mares ovariectomized on days 140 to 210. Those results are similar to the suggestions of the NRC committee (2015).

For those pregnancies that are maintained following the procedure, likely those past approximately 120 days, the development of the foal is not expected to be affected. However, because this procedure is not commonly conducted on pregnant mares the rate of complications to the fetus has not yet been quantified. There is the possibility that entry to the abdominal cavity could cause premature births related to inflammation. However, after five months the placenta should hormonally support the pregnancy regardless of the presence or absence of ovaries. Gestation length was similar between ovariectomized and control mares (Holtan et al. 1979).

Anticipated Complication and Mortality Rates Associated with Ovariectomy via Colpotomy

Between 2009 and 2011, the Sheldon NWR in Nevada conducted ovariectomy via colpotomy surgeries (August through October) on 114 feral mares and released them back to the range with a mixture of sterilized stallions and untreated mares and stallions (Collins and Kasbohm 2016). Gestational stage was not recorded, but a majority of the mares were pregnant (Gail Collins, US Fish and Wildlife Service (USFWS), pers. comm.). Only a small number of mares were very close to full term. Those mares with late term pregnancies did not receive surgery as the veterinarian could not get good access to the ovaries due to the position of the foal (Gail Collins, USFWS, pers. comm.). After holding the mares for an average of 8 days after surgery for observation, they were returned to the range with other treated and untreated mares and stallions (Collins and Kasbohm 2016). During holding the only complications were observed within 2 days of surgery. The observed mortality rate for ovariectomized mares following the procedure was less than 2 percent (Collins and Kasbohm 2016, Pielstick pers. comm.).

During the Sheldon NWR ovariectomy study, mares generally walked out of the chute and started to eat; some would raise their tail and act as if they were defecating; however, in most mares one could not notice signs of discomfort (Bowen 2015). In their discussion of ovariectomy via colpotomy, McKinnon and Vasey (2007) considered the procedure safe and efficacious in many instances, able to be performed expediently by personnel experienced with examination of the female reproductive tract, and associated with a complication rate that is similar to or less than male castration. Nevertheless, all surgery is associated with some risk. Loesch et al. (2003) lists that following potential risks with colpotomy: pain and discomfort; injuries to the cervix, bladder, or a segment of bowel; delayed vaginal healing; eventration of the bowel; incisional site hematoma; intraabdominal adhesions to the vagina; and chronic lumbar or bilateral hind limb pain. Most horses, however, tolerate ovariectomy via colpotomy with very few complications, including feral horses (Collins and Kasbohm 2016). Evisceration is also a possibility, but these complications are considered rare (Prado and Schumacher, 2017). Mortality due to surgery or post-surgical complications is not anticipated, but it is a possibility and therefore every effort would be made to mitigate risks.

In September 2015, the BLM solicited the USGS to convene a panel of veterinary experts to assess the relative merits and drawbacks of several surgical ovariectomy techniques that are commonly used in domestic horses for potential application in wild horses. A table summarizing the various methods was sent to the BLM (Bowen 2015) and provides a concise comparison of several methods. Of these, ovariectomy via colpotomy was found to be relatively safe when practiced by an experienced surgeon and was associated with the shortest duration of potential complications after the operation. The panel discussed the potential for evisceration through the vaginal incision with this procedure. In marked contrast to a suggestion by the NRC Review (2013), this panel of veterinarians identified evisceration as not being a probable risk associated with ovariectomy via colpotomy and “none of the panel participants had had this occur nor had heard of it actually occurring” (Bowen 2015).

Most spay surgeries on mares have low morbidity[1] and with the help of medications, pain and discomfort can be mitigated. In a study of the effects of bilateral ovariectomy via colpotomy on 23 mares, Hooper and others (1993) reported that post-operative problems were minimal (1 in 23, or 4%). Hooper et al. (1993) noted that four other mares were reported by owners as having some problems after surgery, but that evidence as to the role the surgery played in those subsequent problems was inconclusive. In contrast Röcken et al. (2011) noted a morbidity of 10.8% for mares that were ovariectomized via a flank laparoscopy. “Although 5 mares in our study had problems (repeated colic in 2 mares, signs of lumbar pain in 1 mare, signs of bilateral hind limb pain in 1 mare, and clinical signs of peritonitis in 1 mare) after surgery, evidence is inconclusive in each as to the role played by surgery” (Hooper et al. 1993). A recent study showed a 2.5% complication rate where one mare of 39 showed signs of moderate colic after laparoscopic ovariectomy (Devick 2018 personal communication).

Anticipated Effects on Mare Health and Behavior on the Range

No fertility control method exists that does not affect physiology or behavior of a mare (NRC Review 2013). Any action taken to alter the reproductive capacity of an individual has the potential to affect hormone production and therefore behavioral interactions and ultimately population dynamics in unforeseen ways (Ransom et al. 2014). The health and behavioral effects of spaying wild horse mares that live with other fertile and infertile wild horses has not been well documented,

[1] Morbidity is defined as the frequency of the appearance of complications following a surgical procedure or other treatment. In contrast, mortality is defined as an outcome of death due to the procedure.

but the literature review below can be used to make reasonable inferences about their likely behaviors.

Horses are anovulatory (do not ovulate/express estrous behavior) during the short days of late fall and early winter, beginning to ovulate as days lengthen and then cycling roughly every 21 days during the warmer months, with about 5 days of estrus (Asa et al. 1979, Crowell-Davis 2007). Estrus in mares is shown by increased frequency of proceptive behaviors: approaching and following the stallion, urinating, presenting the rear end, clitoral winking, and raising the tail towards the stallion (Asa et al. 1979, Crowell-Davis 2007). In most mammal species other than primates estrus behavior is not shown during the anovulatory period, and reproductive behavior is considered extinguished following spaying (Hart and Eckstein 1997). However mares may continue to demonstrate estrus behavior during the anovulatory period (Asa et al. 1980). Similarly, ovariectomized mares may also continue to exhibit estrous behavior (Scott and Kunze 1977, Kamm and Hendrickson 2007, Crabtree 2016), with one study finding that 30% of mares showed estrus signs at least once after surgery (Roessner et al 2015) and only 60 percent of ovariectomized mares cease estrous behavior following surgery (Loesch and Rodgerson 2003). Mares continue to show reproductive behavior following ovariectomy due to non-endocrine support of estrus behavior, specifically steroids from the adrenal cortex. Continuation of this behavior during the non-breeding season has the function of maintaining social cohesion within a horse group (Asa et al. 1980, Asa et al. 1984, NRC Review 2013). This may be a unique response of the horse (Bertin et al. 2013), as spaying usually greatly reduces female sexual behavior in companion animals (Hart and Eckstein 1997). In six ponies, mean monthly plasma luteinizing hormone[2] levels in ovariectomized mares were similar to intact mares during the anestrous season, and during the breeding season were similar to levels in intact mares at mid-estrus (Garcia and Ginther 1976).

The likely effects of spaying on mares' social interactions and group membership can be inferred from available literature, even though wild horses have rarely been spayed and released back into the wild, resulting in few studies that have investigated their behavior in free-roaming populations. Wild horses and burros are instinctually herd-bound and this behavior is expected to continue. However, no study has documented the rate at which spayed mares will continue to remain with the stallion and band from which the mare was most recently attached. Overall the BLM anticipates that some spayed mares may continue to exhibit estrus behavior which could foster band cohesion. If free-ranging ovariectomized mares show estrous behavior and occasionally allow copulation, interest of the stallion may be maintained, which could foster band cohesion (NRC Review 2013). This last statement could be validated by the observations of group associations on the Sheldon NWR where feral mares were ovariectomized via colpotomy and released back on to the range with untreated horses of both sexes (Collins and Kasbohm 2016). No data were collected on inter- or intra-band behavior (e.g. estrous display, increased tending by stallions, etc.), during multiple aerial surveys in years following treatment, all treated individuals appeared to maintain group associations, and there were no groups consisting only of treated males or only of treated females (Collins and Kasbohm 2016). In addition, of solitary animals documented during surveys, there were no observations of solitary treated females (Collins and Kasbohm 2016). These data help support the expectation that ovariectomized mares would not lose interest in or be cast out of the social dynamics of a wild horse herd. As noted by the NRC Review (2013), the ideal fertility control method would not eliminate sexual behavior or change social structure substantially.

[2] Luteinizing hormone (LH) is a glycoprotein hormone produced in the pituitary gland. In females, a sharp rise of LH triggers ovulation and development of the corpus luteum. LH concentrations can be measured in blood plasma.

A study conducted for 15 days in January 1978 (Asa et al. 1980), compared the sexual behavior in ovariectomized and seasonally anovulatory (intact) pony mares and found that there were no statistical differences between the two conditions for any measure of proceptivity or copulatory behavior, or days in estrous. This may explain why treated mares at Sheldon NWR continued to be accepted into harem bands; they may have been acting the same as a non-pregnant mare. Five to ten percent of pregnant mares exhibit estrous behavior (Crowell-Davis 2007). Although the physiological cause of this phenomenon is not fully understood (Crowell-Davis 2007), it is thought to be a bonding mechanism that assists in the maintenance of stable social groups of horses year round (Ransom et al. 2014b). The complexity of social behaviors among free-roaming horses is not entirely centered on reproductive receptivity, and fertility control treatments that suppress the reproductive system and reproductive behaviors should contribute to minimal changes to social behavior (Ransom et al. 2014b, Collins and Kasbohm 2016).

BLM expects that wild horse family structures would continue to exist under the proposed action because fertile mares, stallions, and their foals would continue to be a component of the herd. It is not expected that spaying a subset of mares would significantly change the social structure or herd demographics (age and sex ratios) of fertile wild horses.

Movement, Body Condition and Survival of Ovariectomized Mares

The free-roaming behavior of wild horses is not anticipated to be affected by this alternative as the definition of free-roaming is the ability to move without restriction by fences or other barriers within a HMA (BLM H-4700-1, 2010) and there are no permanent physical barriers being proposed. However, the study would document the movement patterns of both herd segments to determine any difference in use areas and distances travelled.

In domestic animals spaying is often associated with weight gain and associated increase in body fat (Fettman et al 1997, Becket et al 2002, Jeusette et al. 2006, Belsito et al 2009, Reichler 2009, Camara et al. 2014). Spayed cats had a decrease in fasting metabolic rate, and spayed dogs had a decreased daily energy requirement, but both had increased appetite (O'Farrell & Peachey 1990, Hart and Eckstein 1997, Fettman et al. 1997, Jeusette et al. 2004). In wild horses, contracepted mares tend to be in better body condition that mares that are pregnant or that are nursing foals (Nuñez et al. 2010); the same improvement in body condition is likely to take place in spayed mares. In horses spaying has the potential to increase risk of equine metabolic syndrome (leading to obesity and laminitis), but both blood glucose and insulin levels were similar in mares before and after ovariectomy over the short-term (Bertin et al. 2013). In wild horses the quality and quantity of forage is unlikely to be sufficient to promote over-eating and obesity.

Coit et al. (2009) demonstrated that spayed dogs have elevated levels of LH-receptor and GnRH-receptor mRNA in the bladder tissue, and lower contractile strength of muscles. They noted that urinary incontinence occurs at elevated levels in spayed dogs and in post-menopausal women. Thus, it is reasonable to suppose that some ovariectomized mares could also suffer from elevated levels of urinary incontinence.

Sterilization had no effect on movements and space use of feral cats or brushtail possums (Ramsey 2007, Guttilla & Stapp 2010), or greyhound racing performance (Payne 2013). Rice field rats (*Rattus argentiventer*) tend to have a smaller home range in the breeding season, as they remain close to their litters to protect and nurse them. When surgically sterilized, rice field rats had larger home ranges and moved further from their burrows than hormonally sterilized or fertile rats (Jacob et al. 2004). Spayed possums and foxes (*Vulpes vulpes*) had a similar core range area after spay surgery compared to before, and were no more likely to shift their range than intact females (Saunders et al. 2002, Ramsey 2007).

The likely effects of spaying on mares' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). It is unlikely that spayed mares will change their spatial ecology, but being emancipated from constraints of lactation may mean they can spend more time away from water sources and increase their home range size. Lactating mares need to drink every day, but during the winter when snow can fulfill water needs or when not lactating, horses can traverse a wider area (Feist & McCullough 1976, Salter 1979). During multiple aerial surveys in years following the mare ovariectomy study at the Sheldon NWR, it was documented that all treated individuals appeared to maintain group associations, no groups consisted only of treated females, and none of the solitary animals observed were treated females (Collins and Kasbohm 2016). Since treated females maintained group associations, this indicates that their movement patterns and distances may be unchanged.

Spaying wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether spayed mares would continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that spayed mares would continue to roam unhindered in the Warm Springs HMA where this action would take place. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a spayed animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that spaying wild horses will cause them to lose their free-roaming nature.

In this sense, a spayed wild mare would be just as much 'wild' as defined by the WFRHBA as any fertile wild mare, even if her patterns of movement differ slightly. Congress specified that sterilization is an acceptable management action (16 USC §1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC §1333.2.C.d). Any opinions based on a semantic and subjective definition of what constitutes a 'wild' horse are not legally binding for BLM, which must adhere to the legal definition of what constitutes a wild free-roaming horse[3], based on the WFRHBA (as amended). BLM is not obliged to base management decisions on personal opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Spaying is not expected to reduce mare survival rates. Individuals receiving fertility control often have reduced mortality and increased longevity due to being released from the costs of reproduction (Kirkpatrick and Turner 2008). Similar to contraception studies, in other wildlife species a common trend has been higher survival of sterilized females (Twigg et al. 2000, Saunders et al. 2002, Ramsey 2005, Jacob et al. 2008, Seidler and Gese 2012). Observations from the Sheldon NWR

[3] "wild free-roaming horses and burros" means all unbranded and unclaimed horses and burros on public lands of the United States.

provide some insight into long-term effects of ovariectomy on feral horse survival rates. The Sheldon NWR ovariectomized mares were returned to the range along with untreated mares. Between 2007 and 2014, mares were captured, a portion treated, and then recaptured. There was a minimum of 1 year between treatment and recapture; some mares were recaptured a year later and some were recaptured several years later. The long-term survival rate of treated wild mares appears to be the same as that of untreated mares (Collins and Kasbohm 2016). Recapture rates for released mares were similar for treated mares and untreated mares.

Bone Histology

The BLM knows of no scientific, peer-reviewed literature that documents bone density loss in mares following ovariectomy. A concern has been raised in an opinion article (Nock 2013) that ovary removal in mares could lead to bone density loss. That paper was not peer reviewed nor was it based on research in wild or domestic horses, so it does not meet the BLM's standard for "best available science" on which to base decisions (Kitchell et al. 2015). Hypotheses that are forwarded in Nock (2013) appear to be based on analogies from modern humans leading sedentary lives. Post-menopausal women have a greater chance of osteoporosis (Scholz-Ahrens et al. 1996), but BLM is not aware of any research examining bone loss in horses following ovariectomy. Bone loss in humans has been linked to reduced circulating estrogen. There have been conflicting results when researchers have attempted to test for an effect of reduced estrogen on animal bone loss rates in animal models; all experiments have been on laboratory animals, rather than free-ranging wild animals. While some studies found changes in bone cell activity after ovariectomy leading to decreased bone strength (Jerome et al. 1997, Baldock et al. 1998, Huang et al. 2002, Sigrist et al. 2007), others found that changes were moderate and transient or minimal (Scholz-Ahrens et al. 1996, Lundon et al. 1994, Zhang et al. 2007), and even returned to normal after 4 months (Sigrist et al. 2007).

Consistent and strenuous use of bones, for instance using jaw bones by eating hard feed, or using leg bones by travelling large distances, may limit the negative effects of estrogen deficiency on micro-architecture (Mavropoulos et al. 2014). The effect of exercise on bone strength in animals has been known for many years and has been shown experimentally (Rubin et al. 2001). Dr. Simon Turner, Professor Emeritus of the Small Ruminant Comparative Orthopaedic Laboratory at Colorado State University, conducted extensive bone density studies on ovariectomized sheep, as a model for human osteoporosis. During these studies, he did observe bone density loss on ovariectomized sheep, but those sheep were confined in captive conditions, fed twice a day, had shelter from inclement weather, and had very little distance to travel to get food and water (Simon Turner, Colorado State University Emeritus, written comm., 2015). Dr. Turner indicated that an estrogen deficiency (no ovaries) could potentially affect a horse's bone metabolism, just as it does in sheep and human females when they lead a sedentary lifestyle, but indicated that the constant weight bearing exercise, coupled with high exposure to sunlight ensuring high vitamin D levels, are expected to prevent bone density loss (Simon Turner, Colorado State University Emeritus, written comm., 2015).

Home range size of horses in the wild has been described as 4.2 to 30.2 square miles (Green and Green 1977) and 28.1 to 117 square miles (Miller 1983). A study of distances travelled by feral horses in "outback" Australia shows horses travelling between 5 and 17.5 miles per 24 hour period (Hampson et al. 2010a), travelling about 11 miles a day even in a very large paddock (Hampson et al. 2010b). Thus extensive movement patterns of wild horses are expected to help prevent bone loss. The expected daily movement distance would be far greater in the context of larger pastures typical of BLM long-term holding facilities in off-range pastures. A horse would have to stay on stall rest for years after removal of the ovaries in order to develop osteoporosis (Simon Turner, Colorado State University Emeritus, written comm., 2015) and that condition does not apply to any wild horses turned back to the range or any wild horses that go into off-range pastures.

Effects on Genetic Diversity
It is true that spayed mares are unable to contribute to the genetic diversity of a herd, but that does not lead to an expectation that the HMA would necessarily experience high levels of inbreeding, because there would continue to be a core breeding population of mares present, because horses could always be introduced to augment genetic diversity if future monitoring indicates cause for that management action, and because there is an expectation of continued positive growth in the herd. "Fertility control application should achieve a substantial treatment effect while maintaining some long-term population growth to mitigate the effects of environmental catastrophes" (BLM IM 2009-090). This statement applies to all population growth suppression techniques, including spaying. Periodic gathers allow BLM to collect DNA samples, closely monitor the genetic variability of the herd, and make appropriate changes (i.e. translocation from other HMAs) when testing deems them necessary.

Although BLM is unable to precisely quantify cumulative effects under the proposed action, the effects of this alternative on present and RFFAs and in wild horse and burro habitat would aid in the long-term maintenance of habitat conditions necessary for a thriving natural ecological balance within the HMA. By maintaining AML and potentially slowing the population growth rate of wild horses, the objectives from HMAPs, the ####### RMP/ROD (1992), and the Oregon GRSG ARMPA (specifically the AML, population growth suppression research and water resources objectives) would be achieved and maintained over the long term (at least 10 years). Maintenance of an appropriate wild horse and burro population under this alternative encourages the success of noxious weed treatments, wildfire rehabilitation efforts, and livestock grazing management activities. Maintenance of AML provides consistency in the annual livestock grazing authorizations, with the exception of climatic fluctuations that may influence timing or level of use. Interference competition and/or direct competition for resources among wild horses, burros, wildlife and livestock would be reduced or avoided by maintaining AML.

In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NRC Review (2013) recommended that single HMAs should not be considered as isolated genetic populations. Rather, managed herds of wild horses should be considered as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. It is worth noting that, although maintenance of genetic diversity at the scale of the overall population of wild horses is an intuitive management goal, there are no existing laws or policies that require BLM to maintain genetic diversity at the scale of the individual herd management area or complex. Also, there is no Bureau-wide policy that requires BLM to allow each female in a herd to reproduce before she is treated with contraceptives. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010). There would be little concern for effects to genetic variability of the herd because all action alternatives incorporate BLM's management plan for genetic monitoring and maintenance of genetic variability. (Refer to Monitoring section, p. ##.)

In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, including HMA. As a result, most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives on the HMA. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NRC Review 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result would be expected to slow the rate of genetic diversity loss (Hailer et al. 2006). Based on a population model, Gross (2000) found that a strategy to preferentially treat young animals with a contraceptive led to more genetic diversity being retained than either a strategy that preferentially treats older animals, or a strategy with periodic gathers and removals.

The HMA would have only a low risk of loss of genetic diversity if logistically realistic rates of sterilization or PZP vaccine contraception are applied to mares. After the initial gather, subsequent sterilization and PZP vaccine treatments there would take place only after gathers. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses, and this is apparently true in the HMA as well. Genetic monitoring did not identify any unique alleles in the HMA. Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e., human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition. Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in case where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the female population are permanently sterilized.

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APPENDIX 4: STANDARD OPERATING PROCEDURES (SOPs) FOR WILD HORSE POPULATION-LEVEL FERTILITY CONTROL TREATMENTS

Any fertility control contraceptives or sterilization methods recommended by the Wild Horse and Burro Advisory Board and approved by the EPA, FDA, or other governmental regulatory body will be available for use. The following implementation and monitoring requirements are part of the Proposed Action:

Contraceptives (currently PZP and GonaCon)

1. Fertility control methods would be administered through darting, jab sticks or hand injection by trained USFS or BLM personnel or collaborating research partners or volunteers. For any darting operation, the designated personnel must have successfully completed a nationally recognized wildlife darting course.

2. Horses treated would receive the prescribed dose loaded into darts at the time a decision has been made to dart a specific horse.

3. The fertility control dose is administered using appropriate equipment.

4. Only designated darters would prepare the vaccine/adjuvant and prepare the emulsion. Vaccine-adjuvant emulsion would be loaded into darts at the darting site and delivered by means of a capture gun.

5. Delivery of the vaccine would follow application directions.

6. Safety for both humans and the horse is the foremost consideration in deciding to dart a horse.

7. No attempts would be taken in high wind or when the horse is standing at an angle where the dart could miss the hip/gluteal region and hit the rib cage. The ideal is when the dart would strike the skin of the horse at a perfect 90° angle.

8. If a loaded dart is not used within two hours of the time of loading, the contents would be transferred to a new dart before attempting another horse. If the dart is not used before the end of the day, it would be stored according to manufactures direction and the contents transferred to another dart the next day. Refrigerated darts would not be used in the field.

9. No more than two people should be present at the time of a darting. The second person is responsible for locating fired darts. The second person should also be responsible for identifying the horse, record keeping and keeping onlookers at a safe distance.

10. To the extent possible, all darting should be carried out in a discrete manner. However, if darting is to be done within view of non-participants or members of the public, an explanation of the nature of the project should be carried out either immediately before or after the darting.

11. Attempts will be made to recover all darts. To the extent possible, all darts which are discharged and drop from the horse at the darting site should be recovered before another darting occurs. In exceptional situations, the site of a lost dart may be noted and marked, and recovery efforts made at a later time. All discharged darts should be examined after recovery in order to determine if the charge fired and the plunger fully expelled the vaccine.

12. All mares targeted for treatment will be photographed in a manner to aid in their identification to the greatest degree possible to enable researchers and wild horse managers to positively identify the animals during the project and at the time of removal during subsequent gathers.

13. In the event of a veterinary emergency, darting personnel would immediately contact the on-call veterinarian, providing all available information concerning the nature and location of the incident.

14. In the event that a dart strikes a bone or imbeds in soft tissue and does not dislodge, the darter should follow the affected horse until the dart falls out or the horse can no longer be found. The darter is responsible for daily observation of the horse until the situation is resolved.

Field Castration (Gelding)

Gelding will be performed with general anesthesia and by a veterinarian. The combination of pharmaceutical compounds used for anesthesia, method of physical restraint, and the specific surgical technique used will be at the discretion of the attending veterinarian with the approval of the Forest Service officer.

Pre-surgery Animal Selection, Handling and Care

1. Stallions selected for gelding will be greater than 6 months of age and less than 20 years of age.
2. All stallions selected for gelding will have a Henneke body condition score of 3 or greater. No animals which appear distressed, injured or in failing health or condition will be selected for gelding.
3. Whenever possible, a separate holding corral system will be constructed on site to accommodate the stallions that will be gelded. These gelding pens will include a minimum of 3 pens to serve as a working pen, recovery pen(s), and holding pen(s). An alley and squeeze chute built to the same specifications as the alley and squeeze chutes used in temporary holding corrals (solid sides in alley, minimum 30 feet in length, squeeze chute with non-slip floor) will be connected to the gelding pens.
4. When possible, stallions selected for gelding will be separated from the general population in the temporary holding corral into the gelding pens, prior to castration.
5. When it is not possible or practical to build a separate set of pens for gelding, the gelding operation will only proceed when adequate space is available to allow segregation of gelded animals from the general population of stallions following surgery. At no time will recently anesthetized animals be returned to the general population in a holding corral before they are fully recovered from anesthesia.
6. All animals in holding pens will have free access to water at all times. Water troughs will be removed from working and recovery pens prior to use.
7. Prior to surgery, animals in holding pens may be held off feed for a period of time (typically 12-24 hours) at the recommendation and direction of the attending veterinarian.
8. The final determination of which specific animals will be gelded will be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer.
9. Whether the procedure will proceed on a given day will be based on the discretion of the attending veterinarian in consultation with the Authorized Officer taking into consideration the prevailing weather, temperature, ground conditions and pen set up. If these field situations can't be remedied, the procedure will be delayed until they can be, the stallions will be transferred to a prep facility, gelded, and later returned, or they will be released to back to the range as intact stallions.

Gelding Procedure

1. All gelding operations will be performed under a general anesthetic administered by a qualified and experienced veterinarian. Stallions will be restrained in a portable squeeze chute to allow the veterinarian to administer the anesthesia.
2. The anesthetics used will be based on a Xylazine/ketamine combination protocol. Drug dosages and combinations of additional drugs will be at the discretion of the attending veterinarian.
3. Animals may be held in the squeeze chute until the anesthetic takes effect or may be released into the working pen to allow the anesthesia to take effect. If recumbency and adequate anesthesia is not achieved following the initial dose of anesthetics, the animal will either be redosed or the surgery will not be performed on that animal at the discretion of the attending veterinarian.
4. Once recumbent, rope restraints or hobbles will be applied for the safety of the animal, the handlers and the veterinarian.
5. The specific surgical technique used will be at the discretion of the attending veterinarian.
6. Flunixin meglamine or an alternative analgesic medication will be administered prior to recovery from anesthesia at the professional discretion of the attending veterinarian.
7. Tetanus prophylaxis will be administered at the time of surgery.

The animal would be sedated then placed under general anesthesia. Ropes are placed on one or more limbs to help hold the animal in position and the anesthetized animals are placed in either lateral or dorsal recumbency. The surgical site is scrubbed and prepped aseptically. The scrotum is incised over each testicle, and the testicles are removed using a surgical tool to control bleeding. The incision is left open to drain. Each animal would be given a Tetanus shot, antibiotics, and an analgesic.

Any males that have inguinal or scrotal hernias would be removed from the population, sent to a regular facility and be treated surgically as indicated, if possible, or euthanized if they have a poor prognosis for recovery (FSM 2260). Horses with only one descended testicle may be removed from the population and managed at a regular facility according to policy or anesthetized with the intent to locate the undescended testicle for castration. If an undescended testicle cannot be located, the animal may be recovered and removed from the population if no surgical exploration has started. Once surgical exploration has started, those that cannot be completely castrated would be euthanized prior to recovering them from anesthesia according to policy (FSM 2260). All animals would be rechecked by a veterinarian the day following surgery. Those that have excessive swelling, are reluctant to move or show signs of any other complications would be held in captivity and treated accordingly. Once released no further veterinary interventions would be possible.

Selected stallions would be shipped to the facility, gelded, and returned to the range within 30 days. Gelded animals could be monitored periodically for complications for approximately 7-10 days following release. In the proposed alternatives, gelding is not part of a research study, but additional monitoring on the range could be completed either through aerial reconnaissance, if available, or field observations from major roads and trails. It is not anticipated that all the geldings would be observed but if the goal is to detect complications on the range, then this level of casual observation may help determine if those are occurring. Periodic observations of the long term outcomes of gelding could be recorded during routine resource monitoring work. Such observations could include but not be limited to band size, social interactions with other geldings and harem bands, distribution within their habitat, forage utilization and activities around key water sources. Periodic population inventories and future gather statistics could provide additional anecdotal information about how logistically effective it is to manage a portion of the herd as non-breeding animals.

Spaying

Any spaying methods recommended by the Wild Horse and Burro Advisory Board and approved by the EPA, FDA, or other governmental regulatory body will be available for use. SOPs will be developed following the direction from the BLM.

Monitoring and Tracking of Treatments

1. At a minimum, estimation of population growth rates using ground or aerial surveys will be conducted before any subsequent gather. During these surveys it is not necessary to identify which foals were born to which mares; only an estimate of population growth is needed (i.e. # of foals to # of adults).

2. Population growth rates of herds selected for intensive monitoring will be estimated every year post-treatment using ground or aerial surveys. During these surveys it is not necessary to identify which foals were born to which mares, only an estimate of population growth is needed (i.e. # of foals to # of adults).

3. A fertility control data sheet will be used by field applicators to record all pertinent data relating to identification of the horse (including photographs) and date of treatment. A copy of the form and data sheets and any photos taken will be maintained at the field office.

APPENDIX 5: AML ANALYSIS

Big Summit Wild Horse Territory

Determination of Appropriate Management Level (AML)

Summary

The Appropriate Management Level (AML) for the Big Summit Wild Horse Territory on the Ochoco National Forest was determined through an in-depth analysis and considered criteria from the Bureau of Land Management (BLM) Wild Horse and Burros Management Handbook (4700-1), Forest Service policy (FSM 2260), and the principals of the Wild Free-Roaming Horses and Burros Act (WFRHBA) of 1971 as amended. Consideration was also given to conclusions found in "Using Science to Improve the BLM Wild Horse and Burros Program" chapter on Establishing and Adjusting Appropriate Management Levels (National Research Council, 2013). This is considered to be a compilation of the best available science on the subject and is consistent with direction and other wild horse Territories across the Western United States.

The proposed AML for the Big Summit Wild Horse Territory is 12 to 57 horses to achieve a Thriving Natural Ecological Balance (TNEB) with existing conditions inside the Territory while regulating their population and accompanying need for forage and habitat in correlation with uses recognized under the Multiple-Use Sustained Yield Act of 1960. This AML range is different from the existing AML range determined in the 1975 Herd Management Plan of 55 to 65.

The AML analysis has determined the Big Summit Territory has sufficient water, forage, cover, and space to support a wild horse population and healthy rangelands over the long term. The AML upper limit of 57 wild horses was determined by considering the criteria included within the BLM Handbook 4700-1, which considers the most limiting factor of the essential habitat components of water, forage, cover and space that results in a TNEB, and avoids deterioration of the rangelands while providing for recognized multiple-uses. The most limiting factor for the Big Summit Territory is winter range forage because that is the essential habitat component critical in achieving a TNEB given the resources provided in the Big Summit Territory. The upper limit focused on winter forage available on winters with above average snowfall when wildlife would be displaced to other locations, the lower limit is a number that looked at winters of above-average snowfall but with consideration that forage needs for wildlife would have to be provided inside the Territory.

A herd size of 12 to 57 horses is not large enough to provide genetic variability and there are two previous studies on the Ochoco wild horses (Cothran, 2011 and Mills, 2010) and a recent publication (Deshpande et al., 2019) that indicate a low level of genetic variability already occurs within the Big Summit horses. Implementation of monitoring and management actions are expected to be needed to maintain the genetic variability of the herd over the long term. Possible actions include the following:

- Adjust the sex ratio to favor males to encourage formation of additional breeding harems.

- Translocation of animals that come from herds living in similar conditions to introduce new genetics to the herd.

Big Summit Territory

The Big Summit Territory is located approximately 30 miles east of Prineville on the Ochoco National Forest. The Territory includes approximately 25,434 acres of forested habitat including Round Mountain and Duncan Butte. The general description of the Territory is a mix of ponderosa pine, Douglas-fir and other conifer trees with a variety of shrubs and grasses, creeks and small mountain meadows.

Within the Big Summit Territory, there are various management areas developed from the Ochoco National Forest Land and Resource Management Plan (LRMP) (USDA, 1989). These management areas include General Forest (the majority of the Territory), General Forest Winter Range, Old Growth, Visual Corridors, Lookout Mountain Rec Area and Developed Recreation. In addition to managing wild horses in the Territory, other multiple uses must be considered.

Scope and Methodology

Scope

The scope of this evaluation is limited to determining an AML that would achieve a TNEB for wild horses in the Big Summit Territory. This evaluation will identify an AML range for the wild horses within the Big Summit Territory consistent with current law, regulation and direction using current available information and the best available science.

Methodology

Evaluation of AML considered criteria outlined in H-4700-1 (Wild Horses and Burros Management Handbook, BLM, July 2010). This handbook presents a multi-tiered analysis process to establish and adjust the AML:

- Tier One-determine whether the four essential habitat components (forage, water, cover and space) are present in sufficient amounts to sustain healthy Wild Horse & Burro (WH & B) populations and healthy rangelands over the long-term. In making this determination, the most limiting factor(s) within the Territory should be considered.
- Tier Two-determine the amount of sustainable forage available for WH & B use.
- Tier Three-determine whether or not the projected WH&B herd size is sufficient to maintain genetically diverse WH & B populations.

Tier 1

The four essential habitat components to sustain healthy WH & B populations and healthy rangeland over time are: water, forage, cover and space. The sufficiency for supporting a healthy WH population and healthy rangeland of all four of these components were considered in this analysis, however, there are limiting factors which drive the calculation of AML as explained in the analysis below.

Of the four essential habitat components (forage, water, cover and space), the most limiting factor is winter range forage. Because of a recurring pattern of wild horses moving outside the Territory, cover and space were also considered as a limiting factors.

Table 1: Four essential habitat components for proposed AML

	Forage		Water		Cover		Space	
Wild Horse Territory	Sufficient	Insufficient	Sufficient	Insufficient	Sufficient	Insufficient	Sufficient	Insufficient
Big Summit Territory	X		X		X		X	

Forage

Forage is an essential habitat component to sustain healthy wild horses. The amount of sustSainable forage available for wild horses has been calculated based on plant association mapping and productivity estimates derived from the Plant Associations of the Blue and Ochoco Mountains (Johnson, Jr. and Clausnitzer, 1992) and Plant Communities of the Blue Mountains in Eastern Oregon (Hall, 1973).

Wild horses are required to be managed for inside designated Territories based on the Wild Free-Roaming Horse and Burro Act of 1971 that states they are to be considered in the area where they are presently (December 15, 1971) found. This means that all essential habitats components must be provided for, year round, inside the Territory only, and as part of the natural system. The ability to capture and immediately place horses due to a shortfall of essential habitat components is limited by funding, personnel capacity, facility space and local animal behavior.

A horse digestive system allows them to susbsist on low-quality vegetation by typically maximizing intake (National Research Council, 2013). However, winter weather conditions can have effects on horse population dynamics, specifically, winter weather can directly affect horses through thermal stress, but more often indirectly with snow cover that affects forage availability (National Research Council, 2013). This situation, as found in the Big Summit Territory, creates a temporally density-dependent population where horses are limited to the food-limited carrying capacity in seasonally cold environments, with snow cover (National Research Council, 2013). To minimize resource damage or adverse impacts to animal health, the upper limit of AML will be established in consideration of winter range forage available during winters of above-average snowfall. This is also consistent with a TNEB required by the WFRHBA.

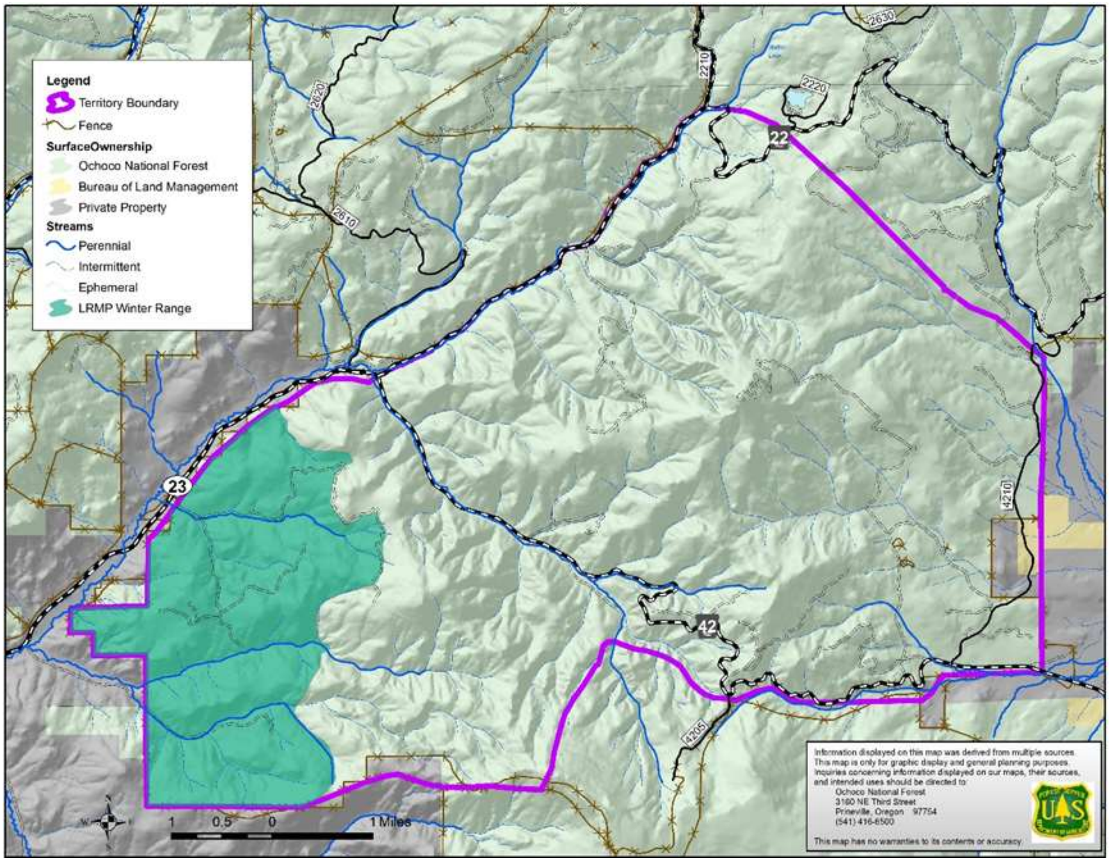
Winter Range

To determine winter range forage availability inside the Big Summit Territory, an in-depth, multi-step analysis was conducted:

1. First a winter range was mapped. The mapped winter range is that area which readily provides forage for wild horses during winters of above average snowfall. In determining the extent of wild horse winter range the following were considered:
    a. Ochoco LRMP designated big game winter range within the Big Summit Territory
    b. Winter survey data from winters of above average snowfall showing wild horse forage use during winter months.
    c. Potential Natural Vegetation (PNV) communities in combination with aspect. In an attempt to determine areas of limited snow depth providing more favorable thermal conditions and forage availability during the winter time.
    d. Elevation thresholds above which snow depth, thermal conditions or forage availability would make forage not readily available to wild horses.
2. Next forage production values (lbs./acre) for PNV communities within the mapped wild horse winter range were adjusted based on factors affecting both site production (tree canopy cover) and accessibility/usage (slope).
3. Next Ochoco LRMP Allowable use factors were determined based upon riparian area existing conditions.
4. Finally forage allocations were determined based upon other multiple-use management direction and consultation with the Oregon Department of Fish and Wildlife and United States Fish and Wildlife Service.

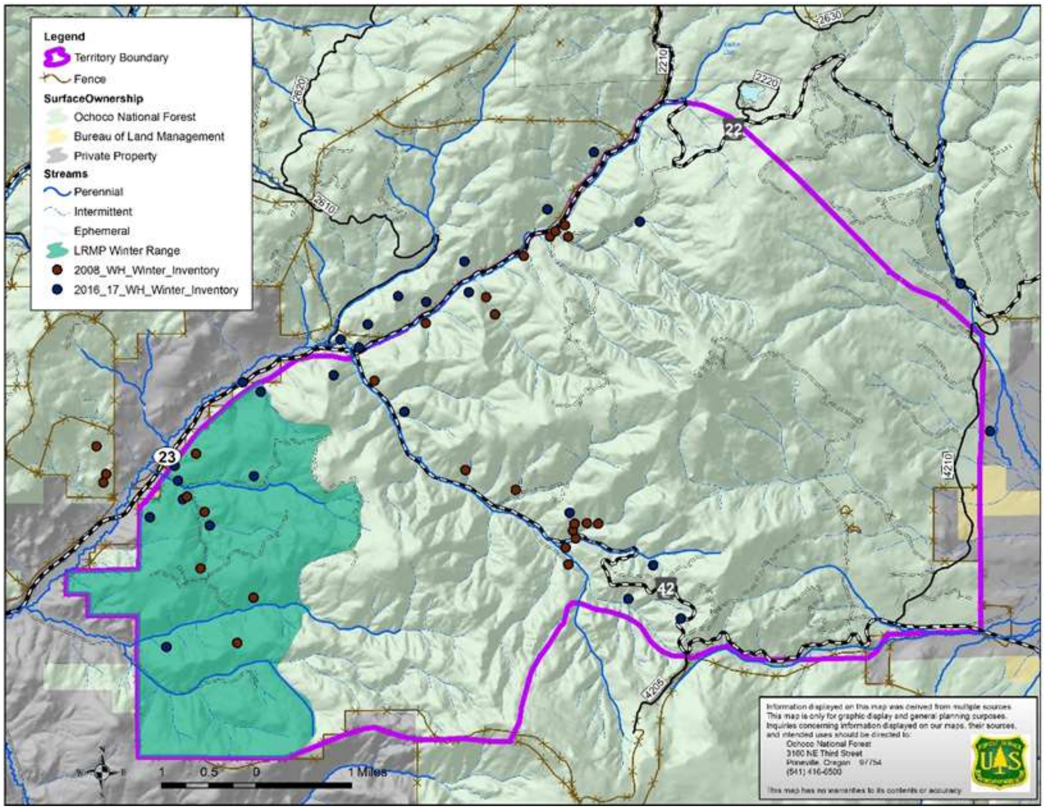
The Ochoco LRMP designated a total of 4,336 acres of General Forest Winter Range for wildlife within the 25,434 acre Big Summit Territory. These acres are located in the southwest part of the Territory bordering private land. Most of the winter range is between 4,000' to 4,600' elevation with the largest range from 3,800' to 4,800'. Nothing in the Ochoco LRMP General Forest Winter Range management area is above 4,800 feet elevation. The General Forest Winter Range inside the Territory was designated based on the presence of wildlife species during the winter time, specifically deer and elk.

Map 1: LRMP General Forest Winter Range inside Big Summit Territory



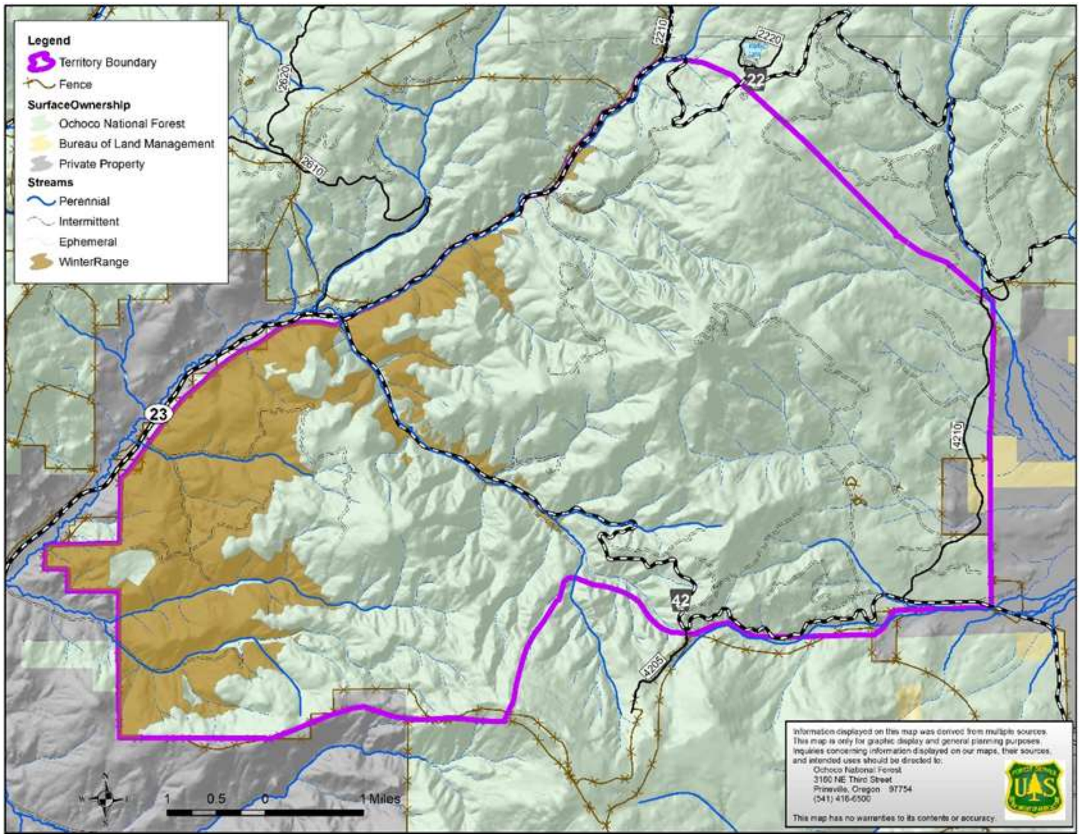
There did not seem to be a good correlation between use of wild horses based on winter range survey data from winters of above average snowfall, and the Ochoco LRMP General Forest Winter Range Management Area designation with the Big Summit Wild Horse Territory. While the area identified as General Forest Winter Range does show traditional winter use patterns by the horses, it is not the only places where horses are repeatedly seen in the Territory during winters with above average snowfall. During these winters horses are also usually seen going up the 22 road to not far below the 22 and 2210 junction as well as along the 42 road on the southern slopes up towards the old Canyon Creek campground. An official winter survey was done in February of 2008 by a collection of volunteers on foot. Results from that survey concluded the repeatable observations of horses were not seen above the 4,600' elevation. February of 2008 showed an above average winter with an average of 146% above the Period of Record percent of official snow water equivalent (National Resource Conservation Service, 2018), overall that winter's snowfall was 117% of average. Winter wild horse surveys were also conducted in February of 2017, that overall winter was 127% of average. The map below shows the comparison of the identified General Forest Winter Range and the survey points from winter horse surveys in 2008 and 2017.

Map 2: Winter Horse Observation Points Compared to General Forest Winter Range



Observed horse occurrence during the winter surveys conducted in 2008 and 2017, did not correspond well to the General Forest Winter Range Management Area designated within the Big Summit Wild Horse Territory but rather seemed to more closely align with an elevation threshold of 4,600'. Based on observation data, during winters with above average snowfall wild horses are commonly found in the lower southwest corner of the Territory where snow depth, thermal conditions and forage are readily available for horses. We also requested data and feedback from members of the public who have information or knowledge on wild horse locations in winter time. Usable feedback received from the public confirmed the apparent alignment with an elevation of 4,600' so we expanded the area to be considered as wild horse winter range. Other factors that did not align with winter observation data include, southern slopes only and certain Potential Natural Vegetation (PNV) communities representing drier environments. Approximately 4,942 acres of the Big Summit Territory falls below the 4,600' elevation threshold that is consistent with most of the known sightings of horses during winters of above average snowfall (Map 3).

Map 3: Wild Horse Winter Range



Water

Water is not a factor limiting healthy WH&B populations and healthy rangelands inside the Big Summit Territory. There are 25 miles of perennial streams inside the Territory and 26 mapped springs. Based on stream survey data collected inside the Territory, streams can provide approximately 121,714.6 gallons per day of water during the summer time (see Table 2). The perennial streams also provide a source of flowing water during the winter time. Horses require 15 gallons of water a day so with 121, 714 gallons per day, other factors are far more limiting than water. There is adequate water for healthy horses inside the Territory leaving enough water for the other resources such as fish and wildlife species.

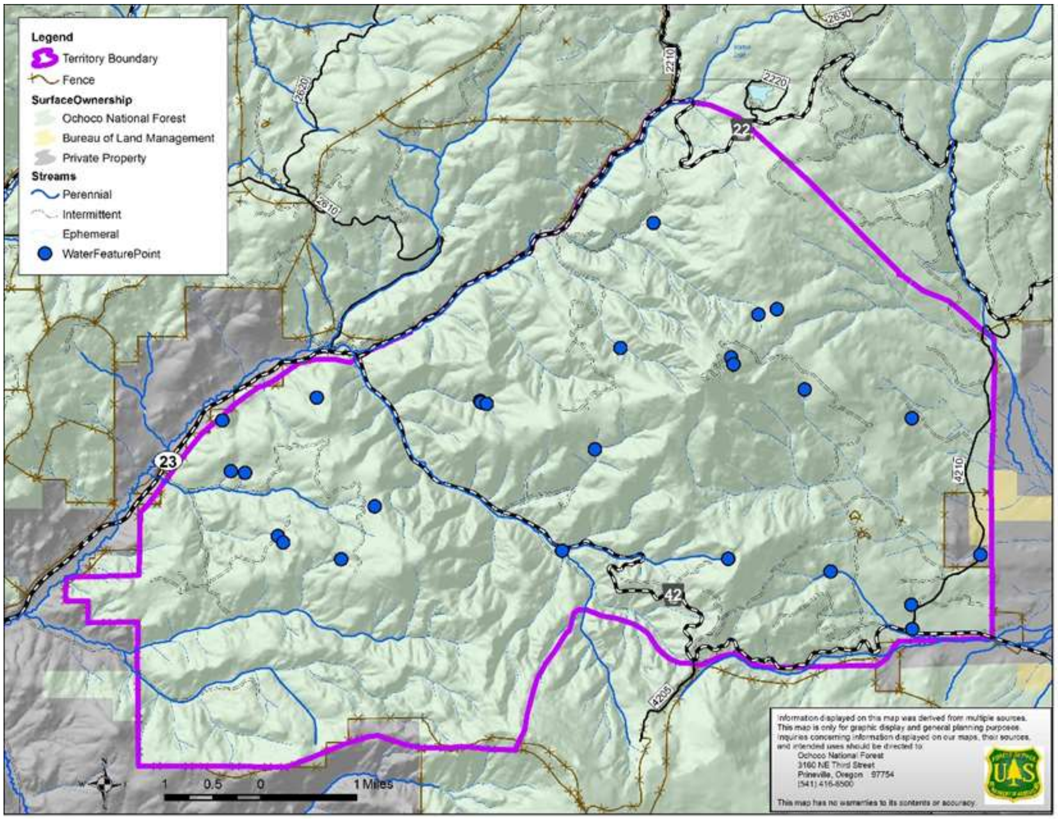
Table 2: Stream Discharge Data inside Big Summit Territory

Stream Name	Reach Location	Date of Survey	Discharge (cubic feet per second)
Cady Creek	Confluence with Ochoco Creek	08/08/93	0.3
Canyon Creek	Canyon Cr. R1	08/11/2015	3
Canyon Creek	Canyon Cr. R2	07/28/2015	3
Canyon Creek	Canyon Cr. R3	08/03/2015	3
Coyle Creek	Confluence with Ochoco Creek	07/20/93	1
Coyle Creek	180600142 2	08/15/2001	0

Stream Name	Reach Location	Date of Survey	Discharge (cubic feet per second)
Cram Creek	Forest Boundary to 1.3 miles upstream	07/07/2015	0
Cram Creek	1.3 miles from Forest Boundary – reach length 1.7 miles	07/14/2015	0
Cady Creek	At confluence with Ochoco Creek	08/22/2005	0
Duncan Creek	At Forest Boundary	07/10/2001	0
Duncan Creek	At 2300-100 road crossing	07/10/2001	0
Duncan Creek	At 2300-150 road crossing	07/10/2001	0
Howard Creek	Forest Boundary	07/10/1991	3
Howard Creek	Just below SF Howard Creek confluence	06/27/1994	2.4
Judy Creek	At confluence with Ochoco Creek	07/02/2001	0
Judy Creek	At 2200-050 road crossing	07/02/2001	0
Judy Creek	At confluence with Ochoco Creek	08/03/2015	0
Ochoco Creek	At Forest Boundary	05/11/1992	10
Ochoco Creek	At Forest Boundary	07/07/1999	4
Scissors Creek	Entire Length	07/2001	dry

In addition to perennial stream water resources, springs also provide water for most of the year. There are 26 mapped springs inside the Territory (Map 4). Data collected on one of two springs inventoried in 2016 showed a flow of 0.24 gallons/minute. Assuming this flow for the remaining 25 springs, these source would provide an additional 8,986 gallons per day.

Map 4: Known Springs in Big Summit Territory



Cover and Space

According to the BLM Handbook, the analysis of adequate space is derived largely from whether the horses stay within the Territory. The "Using Science to Improve the BLM Wild Horse and Burro Program" book from the National Research Council states that the space needs for wild horses is not clear in scientific literature but recommends a discussion of spatial movement of wild horses. For the Big Summit Territory, there is a re-occurring pattern of horses moving off of the Territory. In addition, there is spatial movement of bands inside and outside the Territory with very little pattern evidence. In general, horses tend to move to higher elevations in the late spring and summer and move down in elevation if winter dictates movement for available forage. There appear to be times when horses stay through part or all of the year in the lower elevations evident by the winter range occupied by horses year round.

Vegetation provides necessary cover for horses and there are two key vegetation communities that all wild horses seek, open meadows and tree canopy. For example, horses are often seen in the Territory in more open, flat meadows grazing or at seeps or springs either drinking, grazing or mud-bathing. If not found in meadows, they are often seen seeking shade in tree canopy cover pockets adjacent to meadows. A Geographical Information System (GIS) analysis looked at what we call high probability habitat where horses have the highest preference based on flat, open areas. The GIS analysis used selection criteria of less than 8% slope (Ganskopp & Vavra, 1987) and less than 40% canopy cover (Jameson, 1967) and mapped 1,728 acres in the Big Summit Territory.

Horses are also often found under what is locally known as "noon trees". Trees provide shade that allows horses to avoid direct insolation during the hottest times of the day and a rubbing surface that they can use to scratch (National Research Council, 2013). Wild horses prefer low elevation, drier habitats during winter (Wockner et al., 2003) when they also take advantage of reduced snow-depths at tree bases for foraging (Salter & Hudson, 1979). They will also paw in to feed under snow up to two feet deep or use their muzzle to push the shallower snow away to forage (Salter & Hudson, 1979).

According to the BLM Handbook, horses require enough space to allow the herd to move freely between water and forage within seasonal habitats (USDI BLM Handbook), though exact space requirements are unknown. Cover and space are interrelated. If the Territory has barriers preventing free movement between forage and water, (either natural, such as rivers, or human-induced, such as fences), then the Territory would not have sufficient cover and space. An indication that the Territory does not have sufficient cover and space for the number of horses is a recurring pattern of horses moving outside of the Territory. Such egress is evident in the Big Summit Territory and requires constant management to move horses back into areas where their occupancy is authorized.

A simple comparison of acres per animal was looked at for the Big Summit Territory and all other Herd Management Areas (HMA) in the state of Oregon. We recognize that most of the other HMAs are in a High Desert environment and not a timbered environment but just comparing acres per horse, which is a measurement of space, with the exception of Cold Springs HMA, the Big Summit Territory has the lowest number of acres per horse at the existing Low AML and fourth lowest number of acres per horse at the existing High AML.

Table 3: Oregon wild horse AML/Acre comparison

HMA	**Acreage**	**Low AML**	**High AML**	**Low AML/Acre**	**High AML/ Acre**
Pokegana	16,894	30	50	563.13	337.88
Hog Creek	21,814	30	50	727.13	436.28
Kiger	26,874	51	82	526.94	327.73
Big Summit	27,300	55	65	496.36	420.00
Liggit Table	28,101	10	25	2810.10	1124.04
Riddle mountain	28,346	33	56	858.97	506.18
Cold Springs	29,883	75	150	398.44	199.22
Three Fingers	62,509	75	150	833.45	416.73
Jackies Butte	65,211	75	150	869.48	434.74
Palimino buttes	71,668	32	64	2239.63	1119.81
Stinkingwater	78,305	40	80	1957.63	978.81
Murderer's Creek	107,859	50	140	2157.18	770.42
South steens	126,720	159	304	796.98	416.84
Sand Springs	192,524	100	200	1925.24	962.62
Sheepshead-Health Creek	198,845	161	302	1235.06	658.43
Paisley	297,802	60	150	4963.37	1985.35
Beatys Butte	399,714	100	250	3997.14	1598.86
Warm Springs	474,501	111	202	4274.78	2349.01

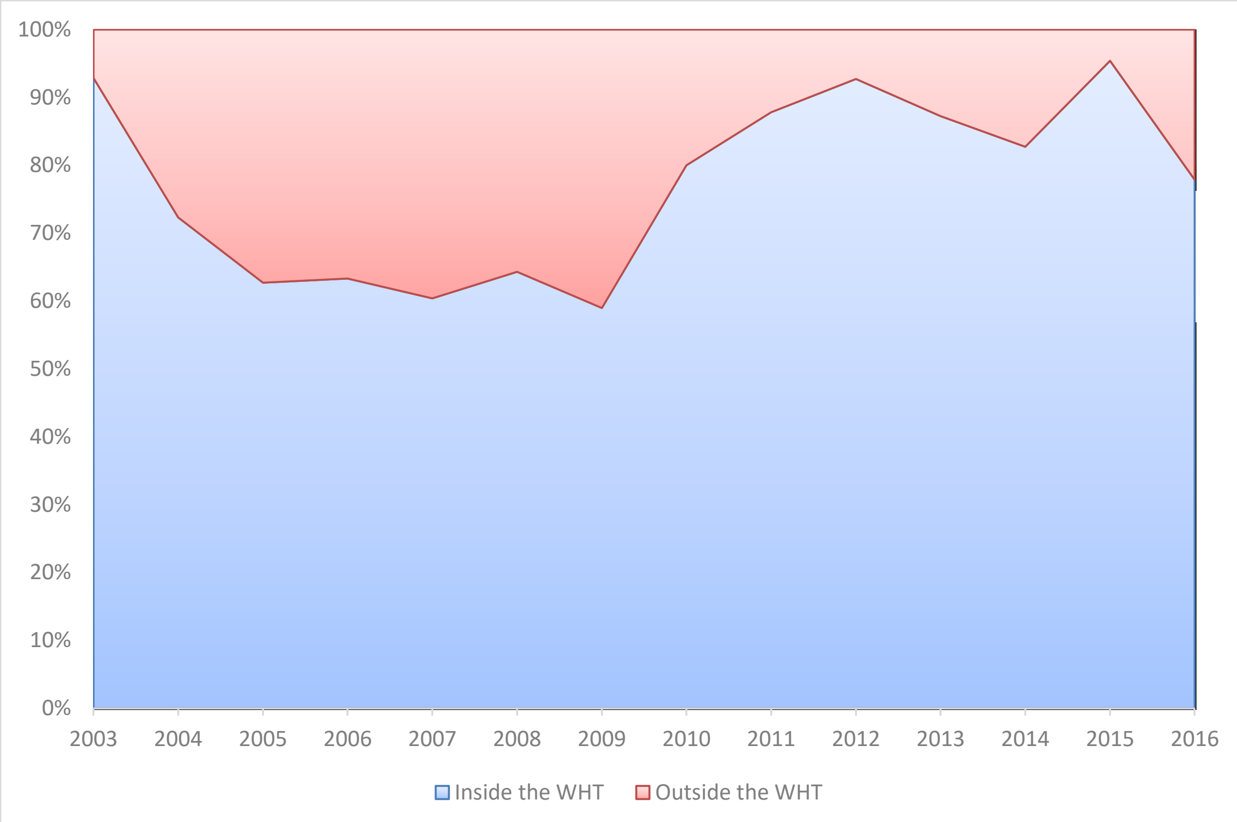
HMA	**Acreage**	**Low AML**	**High AML**	**Low AML/Acre**	**High AML/ Acre**
Coyote Lake/ Alvord Tule	553,603	198	390	2795.97	1419.49

Looking at the history of captures in the Territory from 2002-2010, 5 out of 6 captures targeted horses outside of the Territory. In that same time period, 3 out of the 6 annual census counted horses within the 1975 AML of 55-65 (Table 4). Boundary fences surrounding the Territory were known to be compromised in that time period as well as a lack of management actions to immediately get horse moved back into the Territory. This complicates any evidence of a pattern, therefore, there is not a clear correlation between the number of horses counted for and the amount seen outside of the Territory (Graph 1).

Table 4: Captures inside/outside Territory

Year of Capture	Inside Territory	Outside Territory	Within 1975 AML	Above 1975 AML
2002		X		X
2003		X	X	
2005		X	X	
2006	X		X	
2009		X		X
2010		X		X

Graph 1: Comparison of horses inventoried inside/outside Territory



Another possible indicator of cover and space may be based on horse behavior in the Big Summit Territory. Wild horses usually collect in small bands with a lead stallion and lead mare as well as other mares and recent off-spring (USDA Forest Service, 1975). These bands are dynamic and usually protected by the ability of the lead stallion to maintain the number of mares his capability allows. Typically small herds will be sprinkled throughout a Territory with some small changes occurring annually. When the Territory was established in 1975, there were 10 bands identified ranging in size from 2-10 horses. This was the pattern seen in the Big Summit Territory until around 2010 when a large concentration of horses started to collect in the Cram creek area during June where they remained for most of the summer. This collection started with at least 45 horses in 2010 to a high of 134 horses in 2015. This is not typical behavior of wild horses and the current poor distribution of horses may indicate inadequate cover and space, preventing achievement of a TNEB.

Currently, there is not clear scientific literature on the space needs for wild horses (National Research Council, 2013) therefore, we recognized there is a repeated pattern of horses moving outside of the Big Summit Territory and as the numbers have increased, horses have moved further away from the Territory, however, no adjustments to the AML will be made based on cover and space because there is no clear process described in the literature for how to make such a determination.

Tier 1 of the AML analysis determined that the four essential habitat components for horses (forage, water, cover and space) are present to sustain a healthy wild horse population of undetermined size and healthy rangelands over the long-term; the key is to determine how many horses can be sustained with the essential habitat components present on the Big Summit Territory. In order to make an AML determination it is required to consider the most limiting factor(s) of these essential habitat components for a TNEB. As discussed previously forage availability during winters of above average snowfall is considered to be the most limiting factor for the Big Summit Territory.

Tier 2

Tier 2 of the AML analysis determines the amount (AUMs) of sustainable forage that is available for horse use during winters of above average snowfall within the Big Summit Territory. In determining the amount of available sustainable forage, the principles of multiple use recognized under the Multiple-Use Sustained Yield Act of 1960 including wildlife and permitted livestock must be considered. This determination must also take our current Forest Plan direction into account. In order to do this, we followed a three step process:

1. Calculate annual forage production in the wild horse winter range.
2. Determine allowable forage utilization levels for animals from the Ochoco LRMP.
3. Calculate annual forage allocations available for use by all animals.

Under step 1, GIS mapping was used to calculate plant association acreage based upon the Potential Natural Vegetation (PNV) layer within the 4,942 acre wild horse winter range. Each plant association has an associated herbage production derived from references "Plant Associations of the Blue & Ochoco Mountains (Johnson and Clausnitzer, 1991) and "Plant Communities of the Blue Mountains in Eastern Oregon (Hall, 1973) which collectively represent the best available science for production on these lands. This GIS exercise determined that approximately 4,868 acres of the wild horse winter range has a plant associations with herbaceous production that would be available as forage while74 acres is rocky land that has minimum vegetative production potential and is therefore not considered available as forage.
Within the 4,942 acres of wild horse winter range, 215 acres are in riparian plant communities, and 4,727 acres fall into plant associations that would be categorized as transitory range. Transitory range is defined as forested lands that are suitable for grazing for a limited time following a complete or partial forest removal (Holechek et al., 2000); there is an inverse relationship between the overstory cover and herbaceous production. Research has shown that there is a competitive relationship between overstory and understory vegetation for resources (McConnell and Smith, 1965; Jameson, 1967; Riegel et al., 1992). Because of this, canopy cover data derived from Lidar was mapped in GIS and used to adjust herbage production within the range prescribed by the plant association guides referenced previously. Acreage in the wild horse winter range is listed by canopy cover category and associated production values as follows (Table 5):

Table 5: Canopy Cover and Forage Production Relationships

Canopy Cover Category	Acres	Forage Production
0-25%	995	Highest forage production assumed for particular plant association group.
25-40%	1,119	Average forage production assumed for particular plant association group.
Over 40%	2,828	Lowest forage production assumed for particular plant association group.

There is abundant literature which establishes that there is an inverse relationship between slope and utilization, that is as slope increases, animal distribution and utilization decreases. Specific to horses, the best available science shows decreased utilization on slopes of 20-50% and highest use on slopes ranging from 0-20% (Ganskopp & Vavra, 1987). Because of this, slope utilization reduction rates were applied. The amount of acreage found in the wild horse winter range by slope category and the associated utilization reduction rates are listed as follows (Table 6):

Table 6: Slope Categories and Forage Utilization Reductions

Slope Category	Acres	Utilization reduction
0-20%	1,712	No reduction assumed.
21-30%	1,339	30% utilization reduction assumed.
31-50%	1,572	70% utilization reduction assumed.
Over 50%	319	Not utilized.

Using these criteria for canopy cover relationships and slope utilization reduction, we calculated an adjusted total annual forage production of 1,240,533 pounds in the wild horse winter range (Table 7 shows details of total forage production).

Table 7: Forage Production Calculations by PNV in the Wild Horse Winter Range

PNV Label	Acres	Total Annual Production
CDG111-Doug fir, elk sedge	265	36,091 lbs.
CDG112-Doug fir, pinegrass	1,916	392,399 lbs.
CDS624-Doug fir, snowberry	61	10,769 lbs.
CDS625-Doug fir, mountain snowberry	0.30	89 lbs.
CDSD-Doug fir, dry shrub mix	193	28,070 lbs.
CJS1-juniper, low sage	3	1,718 lbs.
CJS321-juniper, bitterbrush, bunchgrasses	55	11,192 lbs.
CJS4-juniper, mountain mahogany, bunchgrasses	54	16,286 lbs.
CPG111-ponderosa pine, bluebunch wheatgrass	64	21,754 lbs.
CPG112-ponderosa pine, Idaho fescue	22	4,933 lbs.
CPG221-ponderosa pine, pinegrass	26	8,810 lbs.
CPG222-ponderosa pine, elk sedge	760	251,416 lbs.
CPS1-ponderosa pine, sagebrush	10	2,922 lbs.
CPS222-ponderosa pine, bitterbrush, elk sedge	388	52,265 lbs.
CPS232-ponderosa pine, mountain mahogany, elk sedge	59	6,710 lbs.

PNV Label	Acres	Total Annual Production
CPS233-ponderosa pine, mountain mahogany, bluegrass	88	11,067 lbs.
CPS234-ponderosa pine, mountain mahogany, bunchgrasses	65	13,149 lbs.
CPS524-ponderosa pine, snowberry	21	13,619 lbs.
CWG111-grand fir, elk sedge	10	752 lbs.
CWG113-grand fir, pinegrass	468	69,795 lbs.
CWG211-grand fir, brome grass	20	2,016 lbs.
CWS812-grand fir, huckleberry	0.27	117 lbs.
GB4911-scabland grasses	12	2,472 lbs.
HC-riparian cottonwood	9	10,620 lbs.
HQ-quaking aspen	0.60	753 lbs.
MD-dry meadow	7	3,783 lbs.
SD4111-mountain mahogany, bunch grasses	94	24,183 lbs.
SW20-alder wetlands	198	242,784 lbs.
TOTAL	**4,869**	**1,240,534 lbs.**

Under Step 2, LRMP direction (USDA, 1989) displays allowable forage utilization based on types of communities, range management levels and the existing range conditions of those communities. The allowable forage utilization is a cumulative annual use by big game, wild horses and permitted livestock. See Tables 8 & 9 below for specific LRMP direction:

Table 8: Forest Plan Riparian Communities Forage Utilization

Range Resource Management Level	Grassland Communities		Shrubland Communities	
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
B-Livestock use managed within current grazing capacity by riding, herding, salting, and cost-effective improvements used only to maintain stewardship of the range.	40%	0-30%	30%	0-25%
C-Livestock management to achieve full utilization of allocated forage. Management systems designated to obtain distribution and maintain plant vigor include fencing and water developments.	45%	0-35%	40%	0-30%
D-Livestock managed to optimize forage production and utilization. Cost-effective cultural practices improving forage supply, forage use and livestock distribution may be combined with fencing and water development to implement complex grazing systems.	50%	0-40%	50%	0-35%

Table 9: Forest Plan Primary Range Communities (except Riparian) Forage Utilization

Range Resource Management Level	Forested Communities		Grassland Communities		Shrubland Communities	
	Sat.*	Unsat.*	Sat.*	Unsat.*	Sat.*	Unsat.*
B-Livestock use managed within current grazing capacity by riding, herding, salting, and cost-effective improvements used only to maintain stewardship of the range.	40%	0-30%	40%	0-30%	30%	0-25%
C-Livestock management to achieve full utilization of allocated forage. Management systems designated to obtain distribution and maintain plant vigor include fencing and water developments.	45%	0-35%	45%	0-35%	40%	0-30%
D-Livestock managed to optimize forage production and utilization. Cost-effective cultural practices improving forage supply, forage use and livestock distribution may be combined with fencing and water development to implement complex grazing systems.	50%	0-40%	50%	0-40%	50%	0-35%

*Sat.=Satisfactory, Unsat.-=Unsatisfactory

The amount of forage use allowed is based on resource management level, range condition and community type. A range resource management level of B will be used for the Big Summit Wild Horse Territory because the Wild Free-Roaming Horse and Burro Act of 1971 (WFRHBA) requires the Secretary to manage wild horses at a "minimal feasible level". Because the highest level of utilization by wild horses occurs in riparian areas with flat slopes (Ganskopp & Vavra, 1987), this is also confirmed with site specific riparian utilization surveys during the fall of 2017 & 2018 in the wild horse winter range showing utilization rates ranging from 58-80%, the riparian communities forage utilization rates (Table 8) will be considered the most limiting and will therefore be the basis upon which allowable use is calculated. Lastly, in determining allowable use levels for riparian communities, riparian community conditions inside the wild horse winter range need to be categorized as either satisfactory or unsatisfactory condition. The LRMP defines satisfactory condition as forage range condition as at least fair, with anything in poorer condition being in unsatisfactory condition. Data collected inside the Territory was used to determine the current riparian community condition.

Data was collected from five Condition and Trend (C&T) plots inside the Big Summit Territory in 2015, all of these plot locations are outside of the wild horse winter range. These C&Ts were established in 1964 and are permanently-staked upland monitoring sites. Data collected from C&T plots can show plant species composition changes over time. Three of these plots were in fair condition and two of the plots were in poor condition, both plots in poor condition were in dry meadow communities. The table below presents range condition upon reading as well as trends (see Table 10).

Table 10: Condition and Trend Data inside Territory

CONDITIONS ANDS TREND (PARKER 3-STEP)

	Community Type	Vegetation Rating			
		1964	**2004**	**2015**	**Overall Trend**
Canyon Creek C&T 1	Dry Meadow	GOOD		FAIR	↓
Canyon Creek C&T 2	Dry Meadow	POOR	POOR	POOR	↔
Canyon Creek C&T2a	Ponderosa pine/elk sedge	FAIR	GOOD	FAIR	↓
Reservoir C&T 1	Dry Meadow	POOR	POOR	POOR	↓
Reservoir C&T 2	Ponderosa pine/elk sedge	GOOD	GOOD	FAIR	↓

There were three Winward Riparian Study plots collected inside the Big Summit Territory, two of which, the plots on Canyon Creek and Blevins Creek, were inside the wild horse winter range. Alma H. Winward's Monitoring the Vegetation Resources in Riparian Areas provides information on three sampling methods used to inventory and monitor the vegetation resources in riparian areas (Winward, 2000). Vegetation composition data from Winwards cross-section or greenline measurements may be used to categorize seral status of the site, not forage range conditions so a direct determination of LRMP satisfactory or unsatisfactory riparian community condition is difficult to determine. However, fair to good range conditions are usually associated with mid, high or potential seral stages (E.L. Smith, et al., 1995). Therefore, early-seral status would generally be considered equal to poor range condition. The cross-section data is the most important relative to grazing because it measures the vegetation on the meadows adjacent to streams were utilization occurs the most by horses. Both the Canyon Creek and Blevins Creek Winward plots located in the wild horse winter range show dominant early-seral species, equivalent to poor range condition. The full data results are displayed in Table 11.

Table 11: Winward Riparian Study Results

WINWARD RIPARIAN STUDY									
DRAINAGE	**YEAR**	**Cross-section Status**	**Greenline Status**	**Greenline Stability**	**WOODY SPECIES**				
					% Seedling /Sprout	**% Young /Sapling**	**% Mature**	**% Decadent**	**% Dead**
Canyon Creek	2005	Early-seral	Mid-seral	Good	5%	10%	81%	0%	5%
	2015	Early-seral	Mid-seral	Moderate	7%	22%	63%	8%	0%

WINWARD RIPARIAN STUDY									
DRAINAGE	YEAR	Cross-section Status	Greenline Status	Greenline Stability	WOODY SPECIES				
					% Seedling /Sprout	% Young /Sapling	% Mature	% Decadent	% Dead
	TREND	↑	↑	↓	N/A	N/A	N/A	N/A	N/A
Blevins Creek	2005	Early-seral	Mid-seral	Good	4%	29%	66%	0%	0%
	2015	Early-seral	Mid-seral	Moderate	0%	68%	25%	0%	0%
	TREND	↓	↓	↓	N/A	N/A	N/A	N/A	N/A
SF Howard Creek	2005	Early-seral	Early-seral	Moderate	5%	15%	77%	1%	2%
	2015	Early-seral	Mid-seral	Moderate	40%	23%	12%	10%	15%
	TREND	↓	↑	↔	N/A	N/A	N/A	N/A	N/A

Four Proper Functioning Condition assessments were conducted inside the Big Summit Territory, the one on Blevins Creek is inside the wild horse winter range. A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Systems (USDI 1998) states that, “Proper functioning condition (PFC) is a qualitative method for assessing the condition of riparian-wetland areas.” With PFC, creeks are broken into reaches and each reach is walked with an inter-disciplinary team and rated based on multiple factors. Functional ratings and trends (or apparent trends) are qualitative but the process provides an initial assessment on condition. See Table 12 for PFC Information.

Table 12: PFC results for the Big Summit Territory

PROPER FUNCTIONING CONDITIONS

DRAINAGE	REACH	DISTANCE	FUNCTIONAL RATING/TREND
Blevins Creek	1	0.75 miles	Functioning at Risk with No Apparent Trend
	2	0.25 miles	Functioning at Risk with No Apparent Trend
	3	0.25 miles	Functioning at Risk with No Apparent Trend
	4	0.75 miles	Functioning at Risk with No Apparent Trend
Cram Creek	1	0.75 miles	Functioning at Risk with a Downward Trend
	2	0.75 miles	Functioning at Risk with No Apparent Trend
	3	0.5 miles	Functioning at Risk with No Apparent Trend
	4	0.75 miles	Functioning at Risk with No Apparent Trend
	5	0.5 miles	Functioning at Risk with a Downward Trend
	6	0.5 miles	Functioning at Risk with No Apparent Trend
Judy Creek	3	0.75 miles	Functioning at Risk with a Downward Trend
	4	0.5 miles	Nonfunctional
	5	0.75 miles	Proper Functioning Condition
Shady Creek	1	0.5 miles	Functioning at Risk with an Upward Trend
	2	0.25 miles	Functioning at Risk with a Downward Trend

Additional riparian area data like stream survey data can be found in the Aquatics Report and are consistent with an unsatisfactory rating for riparian areas in the wild horse winter range.

In summary, to determine allowable cumulative annual forage utilization from the Ochoco LRMP, factors were selected based on direction and data. Those factors are Grassland Riparian Communities, managed under the Range Resource Management Level B for unsatisfactory condition. All of these selected variables leads to an allowable cumulative annual utilization by big game, wild horses and permitted livestock of 0-30%.

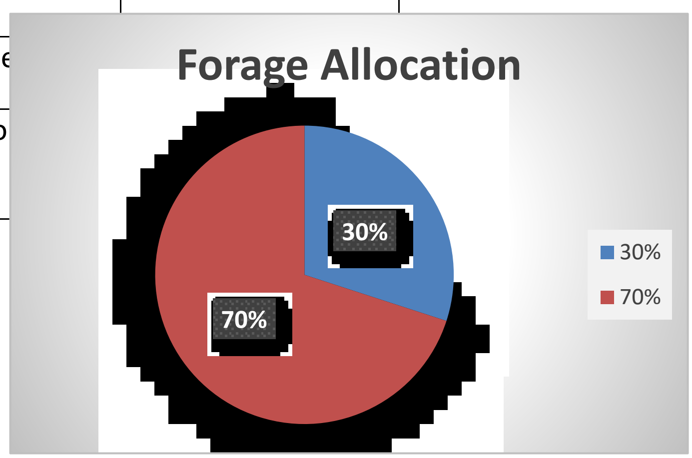
Based on our Forest Plan allowable use standards and guidelines, we multiplied the total annual forage production in the wild horse winter range of 1,240,534 pounds by 30% to get an annual cumulative maximum allowable use of winter forage of 372,160 pounds during years of above average snowfall. In the context of providing for multiple uses this available herbaceous production must provide forage for sheep, big game and wild horses.

1,100 ewe/lamb pairs of sheep are permitted to graze in the wild horse winter range inside the Territory during the summer months for approximately 19 days. This level of permitted livestock use has been authorized on these lands since long before the Big Summit Territory came into existence. Each ewe/lamb pair consumes approximately 8 lbs. of forage a day. The total sheep use in the winter range during the early summer time is 160,875 pounds. This value was subtracted from the maximum allowable use of winter range forage available during winters of above average snowfall (Table 13).

Within the Big Summit Territory, the wild horse winter range overlaps the General Forest Winter Range by 72% and based on current elk populations, which are below the Herd Management Objective, the wild horse winter range should provide winter forage for 151 elk. Each elk demands approximately 26 lbs. of forage a day, of which about 44% consists of herbaceous vegetation in the winter time (defined as 12/1-4/15 based on Sno-tel average snow depth), a direct dietary overlap with wild horses. If all elk remain on the forest during the winter a total of 155,506 pounds of forage is needed for elk in the winter time (Table 13).
Also, because there is a 72% general forest winter range overlap, deer populations must be considered as well. Current deer populations are estimated at 302, which is also below the Herd Management Objective, with an annual forage demand of 5 lbs. a day of which only 5% consists of herbage matter in the winter time. Therefore, deer require a total of 11,778 pounds of forage in the winter time, which was also subtracted from the allowable use of forage (Table 13).

Table 13. Allowable Annual Winter Forage Allocation

Total Forage Production	1,240,533 lbs.
30% forage allocation	372,160 lbs.
Sheep forage needs	160,875 lbs.
Elk forage needs	155,506 lbs.
Deer forage ne	
Wild Horse fo needs	



In order to ensure a TNEB between wild horses, the environment and other multiple use resources, we calculated the average forage need for wild horses through winter and start spring in a good body condition. The nutritional requirements of horses, like many other species, varies greatly between individuals depending upon many variables including size, gender, reproductive status, base metabolism, health status and climatic and environmental conditions. On average horses require 26 pounds of forage daily (USDI, 2010) but research has shown that for every 10 degree F drop in temperature below freezing, forage intake requirements increase by 2 pounds per day (NDSU Extension Service, 2013). We looked at lowest temperatures recorded daily for the five coldest years (1980, 1982, 1987, 1993, 2007) in the last 30 years (NOAA, 2018). We then tallied the days that the lowest temperature was 30 degrees, 20 degrees, 10 degrees, 0 degrees, -10 degrees and -20 degrees and averaged that across the total winter time period from December 1 to April 15th

(135 days). Using these numbers of days, we calculated a daily forage demand during the winter time based on the coldest temperature of the day, the daily winter forage demand averaged 27.5 pound per day per horse. Table 14 shows the breakdown of coldest temperatures during the winter time period. Therefore, with all of the other multiple uses accounted for, the remaining forage would provide enough feed for about 12 horses while not exceeding allowable use levels within the winter range during winters of above average snowfall. This would represent the low end of the AML range.

Table 14. Temperature days and daily forage demand for winter forage needs

Coldest Daily Temperature	# of Days	Daily Forage Demand
30 degrees	70	26 pounds
20 degrees	43	28 pounds
10 degrees	11	30 pounds
0 degrees	7	32 pounds
-10 degrees	3	34 pounds
-20 degrees	1	36 pounds

When defining the wild horse forage available on winter range, we focused on winters with above average snowfall as a limiting factor in order to base our TNEB for wild horses on years that periodically provide harsher situations. Under the Act, wild horses must be managed only in the defined Territory, however, wildlife are not confined physically or legislatively to the territory or National Forest System lands. Due to the high road density associated with the area we determined to be wild horse winter range, habitat effectiveness is low for wildlife. Observations of elk in the wild horse winter range are uncommon especially during winters with above average snowfall. Although elk use the area, use is at low densities and is likely incidental. As a result, on winters with above average snowfall, wildlife move to areas where they can retrieve forage and that provide better security, leaving more winter forage available for wild horses (ODFW, 2019). Considering that this occurs and big game moves off of the wild horse territory during winters of above average snowfall, forage would be available for an additional 45 horses and allow for a high AML of 57 horses.

Summer Forage

Consideration of availability of summer forage was done mirroring the calculations for winter forage but was not used to determine the AML because forage availability during winters with above average snowfall was far more limiting than summer forage availability. In 2006 an analysis was completed to determine the forage availability and proper stocking rates for the two permitted sheep bands within the Big Summit Territory. The analysis looked at the PNV, canopy cover and percent slope on the landscape and made adjustments to the productivity based on those factors. While the two sheep allotments overlap the Big Summit Territory, they are larger than just the Territory, equaling approximately 34,020 acres so the forage production considered for the sheep grazing allotments was larger than what was calculated for the Territory but again, summer forage is not the limiting factor. See Table 15 for a summary of available summer forage.

Table 15: Allowable Annual Summer Forage Allocation

Total Forage Production	9,820,369 lbs.
30% forage allocation	2,946,111 lbs.
Sheep forage needs	1,836,120 lbs.
Elk forage needs	523,620 lbs.
Deer forage needs	28,660 lbs.
Wild Horse needs (high AML of 57)	540,930 lbs.
Remaining forage	16,781 lbs.

Proper stocking calculations were done for sheep on Designated Monitoring Areas (DMAs) located in the Big Summit Territory using utilization measures (based on residual stubble heights and site specific height weight curves and actual use documentation). Residual stubble height measurements were recorded annually at DMAs located in the Territory, three of the four DMAs are also located inside the wild horse winter range. These DMAs are set up to measure permitted livestock grazing in the Territory but also measures horse use (Burton, 2004). For at least three years at each of the four DMAs located inside the Territory, height/weight curves were generated from forage produced within utilization cages in addition to stubble height. The stubble height measurements were compared to the average height/weight production curves (based on at least three years of data) for their respective DMA. The stubble height measurement protocol used during this time only recorded actual stubble heights up to 12-inches, anything over 12-inches was recorded as >12 inches, as a result, during the years that stubble height was >12 inches, a value of 13 inches was used in calculations to provide the most conservative calculations of stubble height. For example, the two DMAs in Canyon Creek, which are also located in the wild horse winter range, measured 7 and 5 of 9 times >12 inches. When used in conjunction with the DMA specific height/weight curves this yielded an average utilization at each DMA. Each of these were compared to the allowed utilization standard in order to calculate proper stocking for each of the given years measured (see Table 16). The proper pasture stocking calculations for each pasture generated an average proper pasture stocking over a ten year period and that stocking rate was then converted to AUMs.

Table 16: Proper stocking use calculations for DMAs in Big Summit Territory

YEAR	NUMBERS	DAYS	AUMs	USE STANDARD	MEASURED USE*	% OF STANDARD
Canyon Creek Herd (WEST)						
2016	994	107	1049	30%	31%	103%

2015	994	107	1049	30%	25%	83%
2014	1042	107	1100	30%	25%	83%
2013	1027	107	1084	30%	25%	83%
2012	1096	107	1157	30%	25%	83%
2011	1046	107	1104	30%	NM	NM
2010	1080	107	1140	30%	25%	83%
2009	1057	107	1115	30%	27%	90%
2008	1091	107	1151	30%	36%	120%
2007	1061	107	1120	30%	31%	103%
AVERAGE	1049	107	1107	30%	28%	92%

*Measured use included above 12 inches stubble height conservative assumption of 13 inches, making this an over-estimate of use.

YEAR	NUMBERS	DAYS	AUMS	USE STANDARD	MEASURED USE*	% OF STANDARD
Reservoir Herd (EAST)						
2016	959	107	1012	30%	34%	113%
2015	948	107	1000	30%	45%	150%
2014	1014	107	1070	30%	29%	97%
2013	1051	107	1109	30%	34%	113%
2012	1080	107	1140	30%	26%	87%
2011	1078	107	1138	30%	NM	NM
2010	1070	107	1129	30%	22%	73%
2009	1050	107	1108	30%	22%	73%
2008	1074	107	1133	30%	22%	73%
2007	1077	107	1137	30%	NM	NM
AVERAGE	1040	107	1098	30%	29%	97%

*Measured use included above 12 inches stubble height conservative assumption of 13 inches, making this an over-estimate of use.

Assuming the DMAs meet the DMA selection criteria (that they reach standard at the same time or before the rest of the pasture) then the calculated average stocking should represent the average animal days of forage that can be consumed to just reach, but not exceed, standards in the pasture. According to our calculations, the summer forage utilization for sheep and horses is consistently below the 30% allocated with a few exceptions, the highest being 45%. This was in 2015 when, based on our annual census, we had the highest number of horses and horse use was very evident in that DMA while sheep grazing remained the same as previous years. These measurements and utilization amounts may include wildlife use during the summer season. Because three of the four DMAs are located in the wild horse winter range, this confirms that summer use, especially for sheep, does not exceed standards.

Prior to winter in October of 2017 and September of 2018, in addition to the DMAs, utilization data was collected on three riparian sites in the wild horse winter range. On October 26 2017, utilization rates ranged from 71-80% on these sites with high evidence of horse use. On September 27, 2018, utilization rates at these same three sites ranged from 58-77% with high evidence of horse use, the sheep did not graze in this area in 2018. Both years, utilization exceeded LRMP utilization standards and both years horses numbers were above the proposed AML.

Tier 3

Tier 3 of the analysis requires determing if the AML generated by habitat components is sufficient to maintain a genetically variable wild horse population. A minimum herd size of 50 effective breeding animals (a total size of about 150-200 animals) is recommended to avoid inbreeding (Cothran, 1991.). If the AML alone is not sufficient to maintain genetic variability, the management options listed below should be considered for inclusion in the management plan to maintain and monitor the genetic variability of the herd:

1. Removing the area's designation as a Territory through the NEPA process.
2. Maximizing the number of breeding age horses in the herd (age 6-10 years).
3. Adjusting the sex ratio to favor males to encourage formation of additional breeding harems.
4. Introducing 1-2 young mares from another HMA or Territory every generation (about every 10 years).

The Big Summit wild horses have had two different small genetic studies conducted, both of these studies indicate low genetic variability. The first study began in 2006 with the purpose of obtaining a non-invasive sampling method for genetic testing and counting of the horses in the Big Summit Territory. Fecal sampling during this study was not effective in identifying individual horses. Thirty-six horse hair samples were collected from captured and adopted horses or from "noon trees" within the Big Summit Territory. Hair sampling allowed for the development of a small DNA database. This study showed many of the small sample of captured horses were "closely related/inbred with 70-80% of the 14 DNA markers assayed being identical." This could be indicative of a small herd that is inbred or these captures may have removed whole family units before the offsprings and siblings could naturally disperse to other areas (Mills, 2010 and Deshpande et al., 2019).

The second study was done in 2011 from 12 samples of horses that were captured in the Big Summit Territory in 2010. Hair samples from two different bands of six horses were analyzed and the results for observed heterozygosity, the chosen measure of genetic variability, was 0.65 and 0.58. The guidance from the BLM handbook is that observed heterozygosity below 0.66 is at critical risk for genetic health. This study concluded that the genetic variability of the herd is low even with the low sample size. This is because the genetic variation, indicated by heterozygosity, is below the critical level and this measure is not influenced by sample size (Cothran, 2011).

Management of wild horses on the Big Summit Territory must balance preserving the horse herd and maintaining the ecosystem they live on (Cothran, 1991). Genetic monitoring can be a tool for maintaining small populations to create/maintain a TNEB. In random mating populations, inbreeding considerations alone require that a minimum viable population (MVP) should not be less than 50 individuals (Franklin, 1980). However, if genetic variation is limited, as is evident in the horses on Big Summit Territory, then enlarging the population size does not increase the genetic variation (Cothran, 2009).

There are other tools that can be used to improve the genetic health of a wild horse herd, such as facilitating smaller breeding units (Cothran, 1991). With the exception of unique herds, like the Kiger mustang, the wild horse population have been subdivided into smaller herds among the various tracts of land (Cothran, 1991). The Big Summit wild horses are part of a larger Meta population that includes other HMAs and Territories across the west that all may have similar ancestry so introducing new genetics from these HMAs or Territories will improve genetic variability of horses in the Big Summit Territory. In 2010, 2 horses from another HMA were relocated into the Big Summit Territory and have successfully reproduced increasing the genetic variation of the wild horses on Big Summit Territory. Bringing new genes from other Territories or HMAs is the primary tool that is prescribed to maintain genetic variation within Territory where habitat components limit appropriate management level.

Because the Territory alone cannot support the number of horses necessary to maintain genetic variation (if genetic depression has not already occurred) and because the horses on the Territory already have low genetic variation, a monitoring program will be utilized to guide corrective actions such as the introduction of new genes from similar Territories or Herd Management Areas or adjusting sex ratios.

Conclusion

This analysis has determined that the Big Summit Territory has the four essential habitat components to maintain a healthy wild horse population at the proposed AML of 12-57 horses. This herd size is expected to result in a TNEB that is consistent with the management objectives and compliant with LMP direction and the multiple use mandate of public lands. The AML was determined by considering the most limiting factor of winter range forage availability during winters of above average snowfall while meeting allowable use standards and LRMP goals and objectives inside the Big Summit Territory. This forage availability was considered in the context of a variety of multiple uses that need to be managed for inside the Big Summit Territory. This population size is inadequate to prevent genetic depression and the lack of genetic variety will require active management to establish and maintain the genetic health of the horses within the territory.

The following represents many factors that have changed between the time the existing AML of 55 to 65 was calculated and the calculation of the proposed AML of 12 to 57.

- Available forage decreased due to an overall increase in canopy cover.
- A much better understanding of the relationship between forage utilization and slope has been developed which represents a change in the best available science in this area.
- Big game populations, both deer and elk, have increased.
- Since 1975, the guidance from the Ochoco LRMP has more detailed direction regarding allowable use of forage.

All of these factors have led to a proposed change in the AML and are displayed in Table 17 below.

Table 17: Comparison of AML factors

	1975	Current	Change
Pounds of Forage	1,482,600 lbs.	1,240,533 lbs.	-242,067 lbs.
Deer	9,048 lbs. (232)	11,778 lbs. (302)	-2,730 lbs.
Elk	20,592 lbs. (20)	155,506 lbs. (151)	-134,914 lbs.
Sheep	160,875 lbs. (1,100 e/l)	160,875 lbs. (1,100 e/l)	0
Forage Use Allocation	33%	30%	-3%

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APPENDIX 6: WILD HORSE WINTER RANGE UTILIZATION PHOTOS

10-26-17 Wild Horse Winter Range Utilization